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THE WANDERING POLYZOON (CRISTATELLA MUCEDO).

BY REV. W. HOUGHTON, M.A., F.L.S.

(*With a Coloured Plate.*)

How well I remember the delight I felt on my first discovery of this beautiful little animal! I hardly know of anything in nature more exquisitely lovely than this, the only locomotive* species of the entire group of Polyzoa. Perhaps that wonderful little rotifer, the *Melicerta ringens*, may almost be considered a greater favourite, for *Cristatella* builds no house with bricks she fashions herself, like that other interesting creature. But still *Cristatella* has charms which even *Melicerta* is unable to display. Just look at a full-grown specimen, of an inch and a half in length, with the triple row of most delicate plumes, arranged around the margin of the body in regular concentric form, and I am sure you will quite agree with Professor Allman, (our great English authority on the fresh-water Polyzoa), who has published a beautiful monograph of this group,† and own with him, that a "more interesting and beautiful animal than a fully-developed specimen of *Cristatella mucedo* can scarcely be imagined." If any of my zoological readers are strangers to this little beauty, I must recommend them to make diligent search, when next summer comes, amidst the stems and leaves of submerged aquatic plants in clear ponds, lakes, and mill-pools; but as the successful hunt after delicate treasures is generally attended with difficulty, and perhaps after many days of patient exploration, with much eye-straining and back-aching in addition, it may be as well to give a hint or two how to proceed in order to find *Cristatella*. And here I may take

* One could almost wish that the specific name of *vagans*, so descriptive of the habits of this Polyzoon, first proposed by Lamark, had been allowed to stand; but the laws of nomenclature are rightly observed.

† Ray Society, 1856.

the liberty of referring to my own remarks, published five or six years ago, in the *Microscopic Journal*,* as I have no reason to "change my prescription," and am unable to give better advice. Where, then, to look for, and how to find *Cristatella mucedo*? As to the first question—where to look?—I must answer, in clear ponds, and lakes, and canals. I suspect that *Cristatella*, though generally speaking, little known, is not nearly so uncommon as some people suppose. I am inclined to believe that this species is as frequently to be met with as some others of the fresh-water group, such as *Fredericella* and some of the *Plumatellidæ*, but while in these last cases an upturned stone, or the under side of a submerged leaf or branch, at once reveals the presence of the adherent specimens—for the sponge-like masses of *Alcyonella*, and the branching tubes of *Plumatella*, are evident to the eye without the slightest effort—it is not by any means so easy a matter to detect the presence of *Cristatella*, whose light-coloured cœnœcium can only with much difficulty, and continued straining of the eyes, be seen, as the little colony rests upon some submerged weed or stone, which weeds, in the middle of summer, are sure to be overspread with the filaments of *Diatomaceæ* and other Algæ, thus rendering the detection of the Polyzoon a task far from easy. Every lake, mill-pond, clear canal, or reservoir may be suspected to contain these most exquisite of the Polyzoa. Now the winter eggs, or statoblasts,† are readily found, much more easily than the developed colony; therefore, let the searcher after these aquatic treasures turn his attention to the discovery of the statoblasts, and let him look for them late in the autumn, in the winter, and spring. In order to obtain these statoblasts—little dark circular bodies about the size of a pin's head, an enlarged representation of which may be seen in the plate which illustrates these few remarks—I would say, go to the sheltered spots in the pool, where the wind has blown all the floating rubbish, duck-weed, tangled masses of Algæ, decayed roots of grasses, etc., and carefully examine the rubbish, bit by bit, in your hands if you like, but the best way is to thin out the rubbish in the water, when small aggregated masses of statoblasts will show themselves, varying in size from that of a pea to an inch in length. The isolated individuals are not, as a rule, to be depended upon, for they are generally only the *separated faces of old specimens*. I have taken home frozen up lumps of rubbish, and have from them obtained statoblasts which have duly germinated, though I have never been able to keep the young polypes alive more

* See the Number for October, 1859, p. 59.

† For further remarks on these bodies, and other interesting particulars, the reader should refer to Mr. Slack's paper in the November No. of THE INTELLECTUAL OBSERVER, 1862, pp. 271—274.

than a few weeks. But if the fully-developed colony is the object of your search, then in the months of July and August, and even in June, if the weather has been warm, go to your pond and seek; be not content with merely stooping down and pulling out the weeds, and examining them in your hands out of the water, for such a search will, in all probability, prove an ineffectual one—it being almost impossible, amid the confervoid growth, to detect the collapsed form of your much-prized *Cristatella*—but lie flat down on the edge of the bank (the Polyzoa are generally within a few feet of the bank, covered by water varying from an inch in depth to about two feet), and put your face close to the surface of the water, staring "with all your eyes;" then, with as little disturbance of the water as possible, clear away with your hand the floating weeds and Potamogeton leaves, and examine every submerged stem *in situ*, just as it grows in the water—with much patience and "great expectations." Probably, for a minute or so, you will see nothing like what you want; but, *nil desperandum*, continue to gaze, and in all probability you will be rewarded by observing, amid the scum and confervæ, an oblong object, feathery and transparent, about an inch in length. These colonies bear some resemblance, when the polypes are momentarily withdrawn, to the well-known gelatinous egg-nidamenta of *Limnæus stagnalis*.

M. Gervais has compared the polypidom to a piece of chenille, and with good reason; it would not be easy to find a more apt similitude. And now that you have seen one specimen *in situ*, you will find little difficulty in being able to discover several more. When the statoblasts split, which happens in the spring, a single polype emerges; in a day or two another grows or buds out of this one, then another, and so on till the colony is developed. I have found that all the fresh-water Polyzoa are great devourers of the spores of Algæ, of Desmidiæ, and Diatomaceæ; so let the observer, who wishes to keep specimens alive for examination, take care to give them a bountiful supply of such food. *Cristatella* is unique in one respect: of all the Polyzoa, whether marine or fresh-water, this alone is capable of locomotion; the movement is certainly very slow, and not easily noticed. The under surface of a Cristatella colony is like the foot of a gastropodous mollusc. "On this disc, which is contractile, and admits of frequent change of shape," to quote Professor Allman, "the colony adheres to neighbouring objects, or creeps about on the submerged leaves and stems of aquatic plants. From the edges of the disc a flat space extends outwards, passing beyond the external series of orifices in the form of a projecting margin, whose interior is occupied by a series of tubular cells or chambers, visible through the translucent skin, and extending in a radiatory

direction from the disc outwards, but possessing no external opening. The tentacula are about eighty in number." Professor Allman states that the cœnœcium (the common dermal system of the colony) is of a dull yellow or sienna colour, and his figure answers to this description. The colour, however, doubtless varies, according to the nature of food and the water where the creatures are found. From my own experience, I should say that the colour of the animal is *light yellow*, which, when viewed by transmitted light, looks almost white, as in the figures of the plate, which were made from drawings of living specimens, which had attached themselves to sides of the glass vessels in which they had been placed. *Cristatella* in other respects differs from other members of the fresh-water Polyzoa; all the rest prefer shade, they are found under stones and in dark recesses, but *Cristatella* loves to flaunt her plumes in the bright glare of day, and good reason she has to be proud of her beautiful feathers! Again, very coy, and shy, and *retreating* are all the others—shake the glass, and in they pop their little delicate heads, and perhaps won't come out again for some little time; but *Cristatella* is not so shy by any means; she must be roughly handled indeed to cause the individuals of the colony to retire into their cells for any length of time.

I will not write more of this beautiful creature. I only ask "Intellectual Observers" to seek to become acquainted with her; and much obliged should I be to any reader of this magazine if he could send me a specimen or two of *Lophopus crystallinus*, or *Palludicella Ehrenbergi*, two British species of fresh-water Polyzoa, which I have long hunted for in vain.

REFERENCE TO PLATE.

Figs. A represent two mature individuals; the dark spots are the statoblasts imbedded in the cœnœcium. B, D, C represent the front, back, and side views of the exserted portion of a single polype; E, a statoblast showing the characteristic hooked spines; all magnified.

LIFE CONDITIONS IN OTHER WORLDS.

THE question of whether other worlds are inhabited by intelligent beings, having other creatures below them, as we have, cannot fail to interest the human mind, and necessarily comes up for reconsideration from time to time as fresh discoveries suggest new thoughts. We have, therefore, thrown together the following pages for the sake of supplying hints drawn from recent investigations. Our object has not been to exhaust the subject, but simply to afford aids for its contemplation.

The association of stars and planets with life reaches back to times when man's dawning reason first studied the celestial orbs, and supposed them the abodes of beings capable of influencing mortal affairs; and when, through the revelations of the telescope, it became known that the planets bore more or less resemblance to the earth, and that the so-called fixed stars might be bodies of the same nature as our sun, it required no great stretch of imagination to conjecture that unnumbered worlds, traversing the fields of space, were inhabited by creatures more or less analogous to man. Fontenelle gave an extensive popularity to these views through the publication of his *Entretiens Sur la Pluralité des Mondes*, in which he asserted that the fixed stars were suns, and that as our sun illuminated planets, so did they. In peopling the various globes, Fontenelle had recourse to a lively fancy, and did not limit himself by any nice considerations of philosophy, so that we are not surprised at his describing lunar cavities, and then asking, "Who knows but the inhabitants of the moon take refuge from solar heat in these great pits?" As science advanced, the different characters of the planets became better appreciated, and it was seen that creatures able to live on our airless moon, or on the huge, light globe of Saturn, must be widely different from those we are acquainted with on the earth. No accurate analogies help us in these inquiries, because our earth does not anywhere exhibit an assemblage of conditions similar to those which any other planet experiences. For example, if we look to Mars, the most earth-like of the planets, we find that by reason of his distance from the sun, he only receives about 43 hundredths of the light and heat that reach us. If this were the only difference, the hottest parts of Mars and the coolest parts of the earth might be compared together; but then we find that from difference of density and size "a body which would weigh one pound on the earth would weigh only half a pound if transported to Mars."* The Martial day of

* Breen, *Planetary Worlds.*

rather more than twenty-four hours and a half does not differ enough from the same terrestrial period to exert any special action upon living beings; but the year contains 669⅔ rotations, and thus the seasons are much longer than our own.

The polar snow and ice masses visible in Mars afford an analogy to our earth, which is strengthened as the observer sees them, diminishing or disappearing as the Martial summer comes on. That Mars has an atmosphere is obvious from inspection, and it forms clouds and deposits moisture like our own. How far it differs from ours we do not know; but the observations of Mr. Huggins, detailed in our last number, show that it contains substances which absorb a good many of the more refrangible rays, and thus cause the planet to assume a red tint. The extent of the polar snow in winter, as compared with summer, shows that a considerable portion of the planet undergoes great changes of temperature corresponding with the seasons; and from the general disposition of land and water—the reverse of what obtains with us—the general climate must be continental, as contra-distinguished from insular.* It was thought at one time that the atmosphere of Mars extended to a considerable distance from the body of the planet; but the observations of Sir William Herschel, who watched minute stars close to the disc, negative this idea. The weight with which an atmosphere presses upon a globe depends upon its density and its height, and upon the force with which gravitation attracts a given mass. In the case of Mars, the atmospheric pressure or density probably does not differ so much from our own as to render that planet unfit to be the abode of creatures bearing some resemblance to those we are acquainted with.

Mr. Huggins finds evidence for supposing that both Jupiter and Saturn have in their atmospheres the gases that occur in our own, though with what admixture does not yet appear. Venus proved about as intractable under the spectroscope as she does under the telescope. Her clouds reflected solar light, and did not permit any sufficient reflection from the body of the planet of rays that had traversed her whole atmosphere, and been affected by the materials it contains.

The amount of resemblance traced between the atmospheres of Jupiter, Saturn, and that of the earth, increases the probability of their inhabitation by beings performing the functions of respiration. The enormous size of the former planet, which is more than eleven times the diameter of the earth, gives it a

* Astronomers usually consider the dark portions seas, and the bright ones land. The dark parts exhibit as much prominence as could be expected from the circumstance of our viewing them through an atmosphere laden with variable clouds. See Mr. Webb's valuable paper, vol. iv., p. 182.

prodigious attractive power, notwithstanding its mean density is, as compared with that of the earth, as 243 to 1000. A mass weighing 100 lbs. on the earth would weigh from 276 to 224 lbs. on Jupiter, according to whether it was placed at the poles or the equator. The surface of Jupiter may be of very small density, as the mean density is low, and "there is reason to think," as Mr. Breen says, "that it is denser at the centre than at the surface." Jupiter receives about one twenty-seventh of our light and heat. If animated beings live upon its surface, they must probably be of very light construction, as we may suppose dense bodies would sink into it, and perhaps tumble down, by mere force of gravity, through successive strata of this remarkable globe.

Saturn has an average density of about three quarters that of water; and if we imagine that it is not homogeneous, but stratified, its external layers must be composed of very delicate materials. Sulphuric ether has a specific gravity of ·724, water being 1; and this fact will assist comparison. Saturn receives ninety-one times less light and heat than we do, but, from its high reflective power, looks brighter than would have been supposed.

If we assume that gravity and muscular activity stand related to each other in the various planets as they do upon earth, we shall find, as Sir John Herschel observes, "that the efficacy of gravity in counteracting muscular power and repressing animal activity on Jupiter, is nearly two and a-half times that on the earth; on Mars not more than one-half; on the moon one-sixth; on the smaller planets probably not more than one-twentieth, giving a scale of which the extremes are in the proportion of sixty to one."

Unless analogy breaks down altogether, the amount of energy displayed by living objects in any planet will bear a constant relation to the quantity of heat it employs in its life processes. We cannot say to the amount of heat it *receives*, because planets may differ very greatly in the proportion of heat which they retain for home use, out of the total quantity that reaches them. We see this from what takes place on the earth. A dry mountain height receives a large amount of solar heat, and gets rid of it by violent radiation; while at a lower level, and with a moist atmosphere surrounding it like a blanket, other portions of the globe that receive less keep themselves very far above the lowest temperature of the regions just named. Sir John Herschel points out in his *Outlines of Astronomy* that we cannot absolutely conclude that objects on Mercury must be seven times as hot, because that planet receives seven times as much solar radiation as we do. Nor are we to assert positively that Neptune is nine

hundred times colder because he receives nine hundred times less. He says, "The feeble sunshine on a remote planet may be retained and accumulated on its surface in the same way, and (for the same reason) that a very slight amount of sunshine, or even the dispersed heat of a clouded day, suffices to maintain the interior of a greenhouse at a high temperature."

The amount of force that can be exerted by a given weight of muscular fibre appears to differ very much in terrestrial creatures, and so does the amount of strength and cohesion of bodies of nearly the same density. None of our larger terrestrial animals exhibit, on their scale, anything approaching to the strength which insects manifest on a smaller scale; and if we compare the action and continuous motion of cilia in animalcules* with the minute portions of matter that are concerned in keeping them going, we are led to conceive that, in some other worlds, considerable locomotive powers may exist in larger creatures not cumbered by our weight of flesh and bone.

The relation of density to cohesion varies exceedingly in substances we are acquainted with. Compare, for example, the solidity of a bamboo with the mobility, and in that sense weakness, of the much heavier body, water; the tenacity of gold, so great that a single grain may be drawn into five hundred feet of wire, with the brittleness that may be communicated to the same metal by combining it with small quantities of certain other substances, so as not materially to change its specific gravity.

It is reasonable to suppose that in planets differing materially in size and density from our own, and also in the quantity of solar heat and light which they receive, the cohesion of substances within a certain range of density may vary much more than they do on the earth, and we must therefore be cautious in our guesses as to how much firmness or weakness may exist in the surface materials of the various planetary worlds.

Recent remarks have shown us that terrestrial life exists under a wider range of conditions than was supposed. On mountain heights, where the atmosphere is half, or less than half, what it is at the sea level, life still appears, and even so highly organized a creature as a condor can soar for hours together 18,000 feet above the sea level, and can live and breed at 10,000 to 15,000 feet elevation. At 18,480 feet the atmospheric pressure is reduced one-half. Dr. Wallich, who has importantly added to and confirmed what was previously known of life at great sea depths, tells us that the Rhizopods

* Ciliary motion is not occasioned by muscles—no one knows how it is produced, and it is found in plants as well as in animals.

called *globigerinæ* are found at depths varying from 50 to 3000 fathoms, and he obtained a live star-fish from 1860 fathoms. At the depth of a mile, the sea pressure amounts to 2640 lbs., or 160 atmospheres, on the square inch. The quantity of free air or oxygen at these great depths must be very small, and respiration low. We may also remark that animalcules can exist in water placed under an air pump, and consequently deprived of a great portion of its air.

The question of the range of temperature that terrestrial creatures can sustain has been considered in one of our recent papers, entitled, "Aids to Microscopic Enquiry;" but, as we have seen, we cannot tell the quantity of heat at the disposal of organisms in the different worlds. Perhaps more light may be thrown upon our speculations if we reflect upon the remarkable discoveries of Tyndall, on the heat absorbing power of aromatic vapours, that of aniseed being 372 times as great as that of common air. Thus the existence, even in moderate proportion, in the atmosphere of any planet, of some heat-absorbing body not found in our own, might very materially affect the temperature to which creatures living on it would be exposed.

In speculating on the power of animals in other worlds, of either producing heat in very cold climates, or resisting it in very hot ones, we may consider the bad conducting properties of many substances we are acquainted with, and of the cooling action exerted by the evaporation of bodies taking up considerable quantities of heat. Our terrestrial plants generate some heat in their vital processes, but, for the most part, too little to enable them to accommodate themselves to a very low temperature. There are, however, cases of very considerable heat being generated by plants in their flowering season, and Dr. Carpenter cites an instance of an *Arum cardifolium* raising a thermometer to 121°, while the temperature of the surrounding air was only 66°. The main source of the heat generated by plants and animals arises from a slow combustion or oxydation of some of the materials they contain, and we find terrestrial creatures adapted to an atmosphere containing only about one-fifth of oxygen. It would be a variation of degree, not of kind, if in other worlds a larger proportion of a gas supporting combustion were supplied, or if organized beings were adapted to burn certain materials at a greater rate.

Mr. Huggins's spectroscope researches lead us to the belief that the atmospheres of the coloured stars absorb a sufficient portion of the complementary rays to give them their peculiar tint. Thus Betelgeux, an orange star, and Aldebaran, a pale red one, exhibit spectra full of lines in the places of rays complementary to the star tint. Aldebaran is described as having

abundance of such dark lines in the orange, green, and blue, and the stoppage of such portions of the spectrum leaves the pale red tint which we see. Now if this be the rule in coloured stars, it will follow that their planets receive rays mixed in different proportions, and as different coloured lights have a different effect upon the growth or organisms, we must expect the planets of a red sun to have a different fauna and flora from a green one. To what extent chemical rays are stopped by certain sun atmospheres, and transmitted by either, we have little knowledge; but the actinic power of some brilliant white or sapphire stars is much higher than that of others which are inclined to an orange tint.* When a binary system exposes its planets to an alternate or varying influence of two distinct coloured suns, not only would their skies and scenery present a splendid and changing aspect, but the sort of stimulus and the amount of excitement given to living organisms would vary too.

The last considerations we shall at present offer refer to a large number of facts now in the possession of naturalists, which show that particular types both of plants and animals may occupy a widely different rank from that which we are accustomed to see them in. Hedgeside weeds in this country are, in many cases, the local representatives of plants that reach ample dimensions in other lands, and the humble reptiles of our roads and ponds claim relationship with gigantic creatures which were little less than the lords of creation in earlier stages of our planet's life. Who knows but that the plants and animals of other worlds are so related to our own, as that they may exhibit the perfect condition of types that are only seen by us in a rudimentary form?

* Most of our astronomical readers will remember a note to page 111 of Mr. Webb's "Celestial Objects," in which it is stated, that "the American astronomers at Harvard College, with the great 22-feet achromatic, have found that Vega surpasses Arcturus in photographic power no less than seven times; presumably from its different hue."

ON TRANSMITTED ILLUMINATION IN CONNECTION WITH THE STRUCTURE OF THE SILICEOUS DIATOM VALVE.

BY RICHARD BECK.

It is undoubtedly a remarkable fact that, after all the careful microscopic examination which has been bestowed for so many years upon the siliceous valves of the Diatomaceæ, no person has yet been able to give any explanation of their structure, which could universally be received as satisfactory.

A few observers appear to have had no difficulty in satisfying themselves as to the cause of those markings which are so familiar to every microscopist; but the opinion of almost every one, who has refrained from any published statement, is as undecided as possible.

I believe the conflicting ideas of some, and the uncertain opinions of others, are easily accounted for by the peculiarities of the case; of these I would especially draw attention to that of the siliceous valve being formed of a perfectly transparent material, and consequently when light is transmitted through it, the markings appear because of the refraction or the reflexion of the light by the various irregularities of structure, and not because of the dispersion or absorption of the light, which so invariably and materially assist us in the determination of almost all natural objects.

Again, it is very seldom indeed that any truly transparent natural object is presented to the naked eye in the ordinary course of our existence, and still less, frequently, under such circumstances as to have a direct light transmitted through it; the only instances that occur to me just now, are the drops of falling rain, or flakes of snow as seen against a light sky, and consequently the eye from not being accustomed to the appearances of transparent objects, is quite unable to come to any judgment upon their appearances.

It has frequently occurred to me, and probably to many others, that some objects of a tangible size might be found to show the difficulty of determining the structure of transparent objects from the appearances produced by passing light through them, and it was quite unexpectedly that I met with a common small glass tumbler, the lower portion of which was covered with small hemispheres. The difficulty of determining the structure even of this large object, when looking perpendicularly though the surface, is at once apparent, and may be seen as well in the accompanying engraving, copied from a photograph,

which was taken after the tumbler had been cut in half, so that the posterior side should have no influence over the illumination or the appearances presented by the anterior surface.*

Now I think every one who will impartially look at the copy of this photograph of the tumbler taken under the conditions of illumination which I have mentioned, must admit that it is impossible from such appearances to determine the true structure; and to show how small an influence may operate upon the mind, in coming to any conclusion, it will be found that merely altering the direction of the illumination exactly reverses the appearance—this change resulting entirely from a very slightly unequal illumination of the hemispheres which conveys the idea of shadow, and consequently elevates or depresses the markings according to the direction of the light by which it is examined.

I do not bring this instance forward as a proof of what the structure of any one diatom valve may be, I believe it would be most hazardous to draw any conclusion whatever: for my own idea is, that a piece of glass covered with hemispherical depressions, or even perforated, might be made to produce very similar appearances.

It may reasonably be asked, what value can attach to such an illustration as this tumbler affords, for the purpose of determining the peculiar and minute structure which no doubt belongs to the diatom valve? I can only give my opinion that it must be taken as negative evidence, and I would recommend those observers who are anxious to determine the correct structure of the siliceous diatom valve, to take into consideration its function, and consequently the formation that that function

* The cut should be viewed as it stands, and then when turned upside down. A piece of paper having a hole in the middle three quarters of an inch square, and laid over the engraving, conceals the true form, and makes it look exceedingly like a portion of a diatom valve.

may require; for how can any reasoning be sound when based merely on the appearances of the markings under the microscope, which, as I have endeavoured to show, may be entirely due to the peculiarity of the illumination, and may give not the least indication whatever of the true structure?

PINK MONADS AND THEIR ENEMIES.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

It is no disparagement to Ehrenberg's genius and industry to say, that the group of Monads (*Monadina*) contains objects that must be entirely re-arranged. Most of them are plants, not animals, and many are probably only rudimentary forms. In the last edition of Pritchard's valuable work, Dr. Arlidge treats the Monads as belonging to a family called *Phytozoa*, composed, as the name indicates, of "plant-like animals." An arrangement of this sort can only be provisional, because many of the objects do not present any animal characteristics, as the mere power of locomotion cannot be considered to deserve that name. The so-called *Phytozoa* comprehend *Monadina*, *cryptomonadina*, *hydromorina*, *volvocina*, *vibrionia*, and *astasia*. The extreme minuteness of many of these objects, and the very small size of their parts, or organs, rendered it impossible that many details could be made out with the object-glasses used by Ehrenberg or Dujardin, and hence we need not be surprised that the former made the mistake of supposing that they possessed a plurality of stomachs, or that the latter found himself unable to do more than suggest artificial appellations, intended merely to facilitate their recognition. The Monad group is divided into two portions, one consisting of isolated individuals, and the other of aggregated individuals. The former are named according to their possessing one or more vibratile filaments and the position in which they are placed; the latter are either always free, or at some portion of their life attached by a stalk. Such an arrangement is evidently artificial, as aggregate groups may, and in many cases do, result from single individuals or spores.

A source of difficulty to students of these organisms arises from the confusion between old and new modes of treating them. Ehrenberg, as we have said, thought them all animal,

and we still find genera, to which animal terms are applied, mixed up with other genera concerning which nothing animal can be predicated. It is not, indeed, easy to say what is an animal or what is a vegetable, and Dr. Burnett observed some years ago, in an introductory note to his translation of Von Siebold's *Anatomy of the Invertebrata*, that "all the older criteria by which animals were separated from plants have long since been regarded as invalid; and some of those which in late years have been regarded among the most constant, have, quite recently, been declared as equally unsound. Cellulose has been shown to be a component of animal as well as of vegetable structures, and Kölliker has insisted that some forms that have neither mouth nor stomach, but consist of a homogeneous mass, are true animals. If these premises are correct, nothing will remain, I conceive, for a distinctive characteristic, but voluntary motion." Afterwards he says, that if stomachless creatures be admitted as animals, still the existence of a stomach should be regarded as proving that an object is not vegetable. Whether or not motion is voluntary, is often an extremely difficult problem to decide, and where no distinct animal organs are present, the class to which the creature belongs must be decided by its preponderating affinities rather than by any one characteristic, and particular attention must be paid to its mode of origin and embryonic forms. A stomachless, organless thing, like the Gregarina, is recognized as an animal partly on account of its young form resembling an Amœba, and thrusting out similar processes. The negative evidence against this, the possessing neither mouth nor stomach, does not deanimalise it; as the tape-worm, which no one would dream of supposing a plant, has no such organs. Moreover, the nutrition of the Gregarina is that of an animal; but as it lives in other animals in contact with their juices, it can imbibe and assimilate them, without the machinery for taking in solid matter, and reducing to a fluid state, which is requisite for the mode of life of other animals higher in the scale.

The absence of a mouth does not suffice to indicate that a living object is not an animal; but the possession of a true mouth is evidence the other way; and none of the various things called Monads, in which mouths can be detected, ought to be associated with other creatures in which nothing but vegetable characteristics can be traced. When an object is not in its complete form, but only a germ, or early stage of something else, it should not be classed with others that may resemble it, but which do not develope into anything else. Until, therefore, the life history of all the objects called Monads is ascertained, their true classification cannot be effected, and

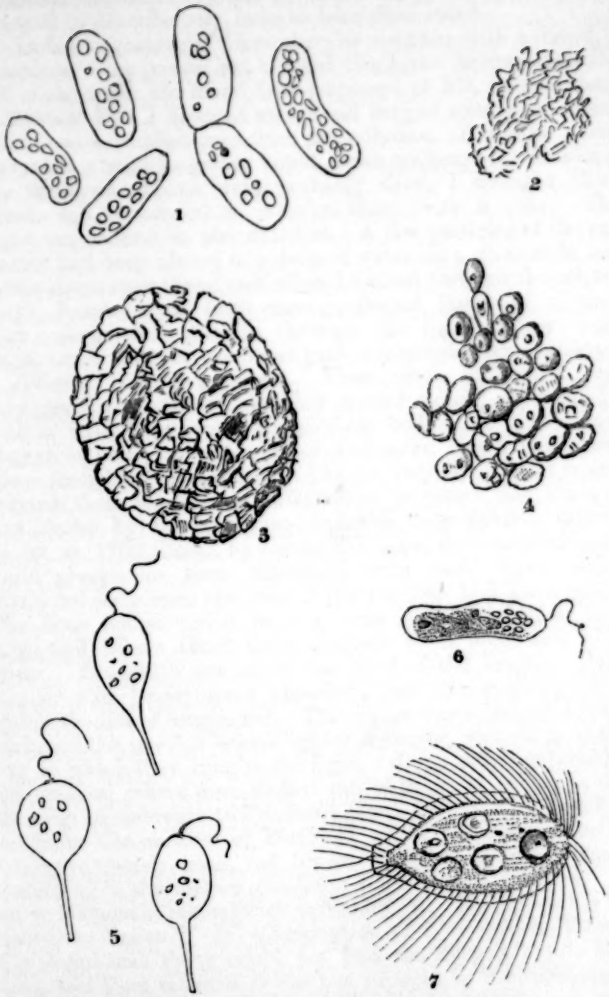


Fig. 1. Pink Monads (Chromatia).
Figs. 2, 3, 4. The same in early stages.
Figs. 5, 6, 7. Animalcules preying upon the Pink Monads.

I cannot pretend to say exactly where the pink Monads I shall proceed to describe may have to take their stand.

In the beginning of December, in company with a friend, I examined some ponds just beyond Highgate Archway, on the left of the road, and found few symptoms of life. After many ineffectual dips, I brought up a small twig of some dead plant which had a reddish hue from the adhesion of minute particles, that a hand magnifier could make nothing of. Thinking the unknown objects were probably alive, I brought them home, and proceeded to examine them with a $\frac{1}{5}$th. The sight was curious in the extreme. A few particles of the red matter had been placed in a drop of water on a glass slide and a thin cover over them, and when I looked through the microscope, hundreds of little sausage-shaped things of a rose-pink colour were moving through the field. They were transparent, and for the most part contained little vesicles of a different refractive power. Their mode of motion was very peculiar. Sometimes they moved nearly horizontally, with a wriggling contortion of their bodies; at other times they stood upright in the water, and spun round and round about their long axis, *appearing* to go very fast, but in reality making their tee-to-tum performance to rather slow time, as was shown by the fact that under a magnification carried as far as 1750 linear, by means if a $\frac{1}{10}$th, the vesicular spots could always be seen separated from each other, which would not have been the case if the rotation had been quick. The little bodies varied in size, some appearing half an inch long, and others about three-quarters when magnified 1750 linear. The width was about one-third of the length. Both smaller and larger were observed, but the majority were within the limits mentioned. The colour was a beautiful rose-pink, and the vesicles looked lighter or darker, according to the way in which they caught the light. Some only contained a few vesicles, others were stuffed full of them, as shown in the drawing. A reference to Pritchard shows that they belonged to the genus *Chromatium* of Perty, of which the description is, "body extremely small, red, brown, green, or violet in colour, containing in the mature condition some internal vesicles. A motor filament at the anterior extremity (?). Multiplication by transverse fission." In a description of *Chromatium Weissii*, it is stated that Perty could not find the alleged motile filament, and I am satisfied it was not present in my specimens, as their mode of progression evidently depended upon another sort of mechanism. No objects are more difficult to make out than extremely small filaments which have as nearly as possible the refractive power of water. Letting a specimen dry will not succeed with the most delicate of such

objects; but changing the refracting power of the water with a little glycerine sometimes will. Cases will occur in which with all care the presence or absence of such a filament must be inferred. Thus I found associated with the Chromatia a number of extremely minute euglenæ from a ten-hundredth to a fifteen-hundredth of an inch long, and it was only in a few specimens the filament could be occasionally seen, though, doubtless, present in all.

In searching for any filament that might be present in the Chromatia, I adjusted the glass and illumination so as to show it in other delicate objects in the same field, but never detected any symptom of such an organ in any one of them. The motion was evidently effected by expansion and contraction of the delicate membrane covering the little objects, and when one of them was in a favourable position a wave motion was seen from one end to the other of the integument. In the annexed plate, a very large Chromatia, is shown in the act of division, but I think the chief method of propagation takes place in another way. After whirling and spinning and wriggling up and down and backwards and forwards for a considerable time, the little sausages grew quiet and settled down among a mass of their brethren, who had likewise retired from the dancing dervish part of their business. They were not dead, though no longer acted upon by "life's fitful fever," and, I believe, in their quiescent state the vesicles escaped and commenced a new growth. When a mass of stationary Chromatia was examined, it was found to be cemented together by a sort of pellicle, in which various objects, including the lilliputian euglenæ, were embedded. This mass likewise exhibited particles of pink matter in various stages of growth, as shown in Figs. 1 to 3. I could not obtain any positive proof of the fact, but I think the little objects in these patches were developing into Chromatia; at any rate a tolerably complete series of forms intermediate between the little dots in Fig. 1, and the objects in Fig. 4, could be traced, and it will be seen that Fig. 4 closely approaches the Chromatium form. All these objects had a pink tinge, but it was deepest in the full-grown specimens.

When I first brought the pink Monads home, there were very few full-grown ones that did not exhibit many vesicles; but, after the bottle containing them had been a week in the house, the majority had very few vesicles, and some none at all, though quite large enough to be entitled to many. The development of vesicles had evidently been checked by want of some conditions I was unable to supply.

It is of no use to give such objects specific names, unless it can be shown from their life-history that they are really

distinct from other objects much like them. The colour cannot be taken as a sufficient distinction to mark a species, nor can variation in size, unless both striking and hereditary. My Chromatia were all rose-pink, but I should not regard them as distinct from violet or brown sorts. They colour mud and other objects at the bottom of ponds. Those I took were only a few inches under water, and the hue is probably affected by the depth at which they grow, and the quantity of light they receive.

The most active enemies of my pink Monads were the creatures represented in Fig. 5. It is quite impossible to represent the delicate structure of these objects in any engraving. The reader must imagine the globular body to be white and transparent; the little dots inside them represent vesicles obtained from the Chromatia, and ingulped by a mouth opening wide and slantingly near the filament. Not a vestige of this mouth could be discerned except when it was in the act of opening or shutting. No definite internal organs could be discovered in my specimens, but no doubt some existed. The filaments were so delicate and colourless that they could only be seen at favourable moments. The slightest motion which took them out of the exact focus, or the best possible illumination, rendered them invisible. The tails were still more delicate, and although both head and tail were frequently seen in the same individual, it was rarely possible to focus both at the same time. Their tails were susceptible of considerable variation by lateral expansion and contraction, and the animals could change from the globular form to a pear shape, or even to the shape depicted in Fig. 6, which represents what may be another species, as it had no tail, and did not become either globular or pear shaped. The most common forms of these animals are represented in Fig. 7. They were very active, swimming freely, squeezing themselves through obstacles, and dashing furiously against the Monads. Sometimes they swallowed a little Monad whole; but their usual plan was to tug and thump at the big ones until they could get at their contents. The object depicted in Fig. 6 was less common, but apparently engaged in the same business.

Fig. 7 shows an animalcule remarkable for the length of its cilia. It had a conspicuous contractile vesicle and a mouth at the smaller end. It was an active creature, and seemed fond of the Monads in an early stage of their growth.

In one instance, one of the Fig. 5 objects used his tail as a foot, and sprung up and down from it, but without the jerk of a Vorticellid.

I have seldom met with prettier objects than the pink Monads and their enemies, and if any of my readers notice a

delicate deposit of pink or any other colour at the bottom of a pond, I recommend them to bottle some of it for domestic use. The sketches which illustrate this paper are from drawings by my wife; the objects are all magnified 1750 linear.

THE AUSTRALIAN SATIN BIRD AND THE KING PARROT.

BY "AN OLD BUSHMAN."

THE male Satin or Shining Bower Bird (*Ptilonorynchus holocericeus*), with his silky, glossy, purple coat and bright blue eye, is, perhaps, take it altogether, one of the most beautiful birds in the Australian forest. But it is not so much on account of the beauty of plumage that I bring this bird before the notice of the reader, as to offer a few remarks on those peculiar little structures called "bowers," which these birds erect in certain places in the Australian bush for the purposes of mutual recreation, and *totally independent of, and often at a considerable distance from, their nests.* These bowers are, I believe, built, and certainly are used by more than one pair of birds. Like human edifices, they do not appear all to have equal care bestowed upon their construction, or equal taste shown in their decoration, and, although uniform in their plan, I do not think that they are equally so in their dimensions. They may, however, be generally described as being in plan an oval, intersected at either end by a wing, or entrance to it. The greatest width of the oval is generally about eighteen inches, that of the wings about eight inches at their points of junction with it. The floor of the oval or bower, and of that portion of the wings immediately adjoining it, is paved with small sticks, along either external edge of which is built a little ridge composed of sticks laid longitudinally, and forming, as it were, two wall-plates. Into both of these wall-plates a compact hedge of sticks is then inserted; these on either side inclining inwards, at about an angle of sixty degrees from the actual covering of the bower, leaving a small space open at the top, varying in size from one to two inches. These sticks are longest in the centre of the bower, and are shortened as they approach either wing. The wings widen as they recede from the bower, and those forming their sides are placed further apart; these also incline inwards. The whole of the sticks

used in the construction of this little edifice are either peeled, or else have a beautifully smooth bark. The decoration of the bower is accomplished by sticking the feathers of gaudy parrots into the wall-plates, especially where the bower and wings intersect each other. The whole of the flooring is also more or less thickly strewn with these feathers, especially at the entrance of the wings, forming a kind of tesselated pavement to the whole affair. It is most ludicrous to watch the grotesque postures and attitudes of a group of satin birds at play in one of these bowers.

Scarcely less beautiful in plumage, and quite as interesting in his habits, is the Spotted Bower Bird, which is very common on the Murray, frequenting the densest part of the mallee scrub. Shy and retired in its habits, and certainly not so gregarious as the bird last described, the male bird of this species is certainly a very handsome fellow, of a rich brown covered with buff spots, and a broad stripe of feathers growing out of the back of the neck, bearing a remarkable resemblance to the flower of a Scotch thistle. But the Murray bird lacks the splendid eye of his royally apparelled brother of the Western port district, of whom, when in full and mature plumage, with his glossy coat of satin-like softness, the lustrous depth of whose purple hue is enhanced by the still brighter glories of a peerless eye, it may be fairly said, he is justly entitled to be classed among those "things of beauty" which are "a joy for ever."

I do not think that any country in the world is richer than Australia in different species of the parrot tribe; and brilliant as many of them are in their colours, to my fancy there is none to equal the King Parrot (*Aprosmictus scapulatus* of naturalists), nearly the size of the magpie at home; the body colour of a rich glossy purple green, with a breast of flaming red. The king parrot, as he floats from one green tree to another, is one of the most splendid objects in the Australian bush, and, although the red lory is a magnificent bird, he must yield the palm to the parrot we are now describing. However, beyond the gorgeous plumage of this princely bird, there is little of interest to be said respecting him, for, unlike the lyre bird, he has no language, save the confused jabber of his "corroboree" notes, and the short, but shrill pipe of his monotonous call-note. Unlike the bower bird he is no builder, and I introduce him here simply in illustration of the fact that Victoria has also her birds of beauty, which can scarcely be surpassed in richness of plumage by those of the sunniest clime. The geographical range of the king parrot is I believe very extensive, but in Victoria, the Gipps' Land district is undoubtedly his chief abiding place, for the further east you

travel, the oftener will your path be crossed by this "dashing pioneer." It is also seen frequently in the Goulburn district, and I have met with him as far north as Mount Hope; but there, as in some other places, I found that he had a dangerous rival in the graceful and golden-fronted green leek parrot, and a little lower down the Murray by the more sombre, yet noble black-tailed lory. He is often to be seen in the Bass River district, sometimes accompanied solely by his unpretending queen, at others in the mixed company of his compeers. Here, during the months of winter, they are to be found in many of the gullies on the mountain ranges, keeping company with the lyre bird and the Yankata cockatoo; and in the same gully, and doubtless often under the same trees, whilst they are quietly feeding in the upper branches, the lyre bird is talking to them in their own language at the foot. At this time of the year they are remarkably quiet, and, owing to the density of the upper foliage in these mountain scrubs, you may traverse gully after gully in these sequestered ranges, swarming with king parrots and other birds, and yet be entirely ignorant of their presence, and the only way to arrive at a knowledge of their vicinity is to repeat at intervals their short and monotonous call-note, and then as likely as not you will hear it answered from a tree under which you have just passed.

In the spring the greater portion of these birds leave their mountain home, and descend into the lower country adjoining it, and when this is the case, our friend proves himself not only the "king of parrots," but the "king of robbers," stripping the fruit from the trees in the settlers' gardens; and of all vegetables, potatoes appear their favourite. After a time they return to the ranges to rear their young, and when this is done they reappear with augmented forces to "raid" in the surrounding country. I think the king parrot right well and worthily named; for although some may perhaps say that the dashing dress of the blue mountaineer is brighter in its hues, and that of the crimson-coated lory deeper in its dye, yet neither the one nor the other, nor in fact any of the parrot race, can, in my humble opinion, vie in stateliness of carriage or splendour of appearance with their "titled king," for the bright red tint of his front and lower garniture stands forth in bold relief from the dark purple and green of his lordly back, while the bright reflection from his dark green wing, as it flashes in the rays of the noon-day sun, dazzles the eye of the beholder, and proclaims the presence of a "Prince of the Birds of Air."

THE DOG AS A CULPRIT.

BY JONATHAN COUCH, F.L.S., ETC.

THE history of the dog, with its peculiar sagacity and fidelity, has been treated of in several volumes especially devoted to the subject; and numerous are the tales illustrative of the same which still remain unrecorded, but which ought not to sink into forgetfulness. But there is a portion of the character of this animal which appears to have escaped the notice of the writers of canine biography, but which has so far a bearing on its acquired or intuitive intelligence as to show that there may be times when its fidelity to the master or the public property may be at fault, while the powers of reasoning and the force of cunning calculation are not diminished.

The state of things to which we refer is well known to farmers, and, as far as our information goes, appears to be confined to that variety of the canine race which is employed in the care of sheep; which form or variety of this animal is believed to stand the nearest to what is understood as the primitive, or natural condition of the race, and which may therefore be judged to be disposed more naturally than others to fall back into the true state of nature, and to be less influenced or governed by anything which education or long habit may have implanted within it, but in which the love of selfish indulgence has again become the governing principle, and what remains of the artificial state is employed only in its own behalf. Other animals which have been brought into subjection to the dominion of man have sometimes shown a propensity to fall back or return to the primitive condition of their race, of which what we term wildness, and an ungovernable appetite, are the usual characteristics; and even the "half-reasoning elephant" is not always exempt from the same propensity; but in the case of the dog it is remarkable, above what has been noticed in other creatures, that with the savage appetite which has excited the individual to throw aside the long-practised restraint of education, there should be brought into exercise so large an amount of shrewdness as even to exceed what has been manifested on ordinary occasions.

When, therefore, it happens that, amidst the fulness of an abundant larder at the house, a craving shows itself for a supply of raw and newly-slain mutton, it is not from the nearest, and still less from its master's flock, that the want is to be supplied. We can scarcely admit that in this there is any special regard for the master's interest, or love for the individual sheep of the flock; for the depredator trots off to a

considerable distance from even the fields of a near neighbour, for whom no particular feeling of regard can be supposed to exist. The mischief is also to be inflicted in such situations and under such circumstances as appear the least likely to be traced, or the source suspected from whence the robber has come. As the injury brought on the flock is inflicted at night, it is highly probable that the first will pass without a discovery of the perpetrator. But impunity will bring upon the offender the largest degree of danger, and a watch is kept; under which circumstances it is that our earliest observations have been made, in pursuing which we have been impressed with the amount of stratagem that has been put in practice, more especially to secure the escape of the criminal, and even to divert the suspicion which might alight upon him. The only failure in calculation of results appears to be, that where it has been successful already, a dog will probably resort again to the same field for the same object, without being aware that a second attempt will probably lead to discovery; but in all besides, no London pickpocket is better versed in the subtleties of his art.

As illustrations of the foregoing remarks: A dog was observed to have throttled a sheep, and after having satisfied its appetite, it went down to a neighbouring mill-pool, with what intention it is easy to guess, and there, not aware of being noticed, it washed itself thoroughly, and then came to the bank, where it dragged itself along the ground; after which it went again into the water, rubbed its mouth in the grass, and only after a long time did it venture to return to its home—there, however, to suffer the penalty of the transgression, the whole of which had been seen, but of which, if there had not been other evidence, the appearances on the dog could not have been brought as a proof.

On another occasion, a dog had killed some sheep at the distance of about a couple of miles from his home, and in a secluded situation; but being discovered in the act, it was shot at with a gun, wounded, and pursued. The farm which was its home was on the east border of a promontory that projected far into the sea; but instead of proceeding straight to the shelter of its residence, the road to which was not difficult, although intersected with several cross roads, it ran first to a beach far on the west side of the promontory, and from thence swam out among the rocks, on some of which it effected a landing two or three times. It landed finally on the east of its master's farm, and there was observed to wash its bleeding wounds; after which the parts were rubbed in the earth, and at last it crept up slyly to its own house, where it lay down on the straw with the appearance of being asleep. The

pursuers who had traced the proceedings of the dog had, in the meanwhile, roused up the master from his bed, and they proceeded together to drag out the murderer from his lair; but in doing this, poor innocent! it appeared altogether drowsy and unconscious of harm. Proof was, however, afforded, even to the master's conviction, in the discovery of the bleeding wounds, and summary vengeance was the result.

A dog had worried and much injured a sheep at the distance of a quarter of a mile from its master's house; but being discovered by the farmer, who knew the dog, it made all haste to its master's house in the neighbouring town, where the master was sitting by the fire, and another dog lay at his feet asleep. Advancing, with all the appearance of conscious innocence, this one lay down by the side of its canine friend, and presently assumed the appearance of being also asleep. Presently, however, the unwelcome pursuer appeared also, and began to tell the tale of the injury inflicted on his sheep. The really innocent dog continued to sleep on; but the conscious culprit, without looking up, crept silently away, not directly, but round the room, and was not long in quitting the house. Very near to the master's house was a cellar or room, which was used for the purpose of *barking* the nets of the fishermen, and a portion of the apparatus consisted of a boiler with a flue, close into which latter it crept, entirely out of sight, and there it was discovered, to suffer the necessary consequence of the crime. It is clear that in this instance the dog not only knew the person of its pursuer, but the purport of his tale, as well as that its attempt to lull suspicion had failed of effect.

Subtlety, as deep as in these instances, we have known in a captive fox, and almost as deep in a cat; but in these actions of the dog, a nearer approach is made to the human vice of hypocrisy than we have noticed in any other animal.

While on this subject we will add another narrative, which represents this creature in a more amiable point of view. A gentleman possessed a retriever bitch, which had produced two broods of puppies, all of which had been taken from her and drowned. She was about to produce another litter, and was observed to have searched through every corner and spot about the house; but after a time she disappeared, and when again seen it was plain she had been relieved of her load. Search was then made for the young ones; but it was long before they were discovered, and then it was far from the house—in a secret place on the shore of the sea, near where otters had had a residence; and even then the place was so chosen among the rocks that the young ones could not be got at. It is plain in this instance that the resolution for this proceeding had been formed in the mind long before, although only lately carried out.

MICROSCOPIC CRYSTALS (URIC ACID AND ITS DERIVATIVES).

BY GEORGE S. BRADY, M.R.C.S.,
Secretary to the Tyneside Naturalists' Field Club.

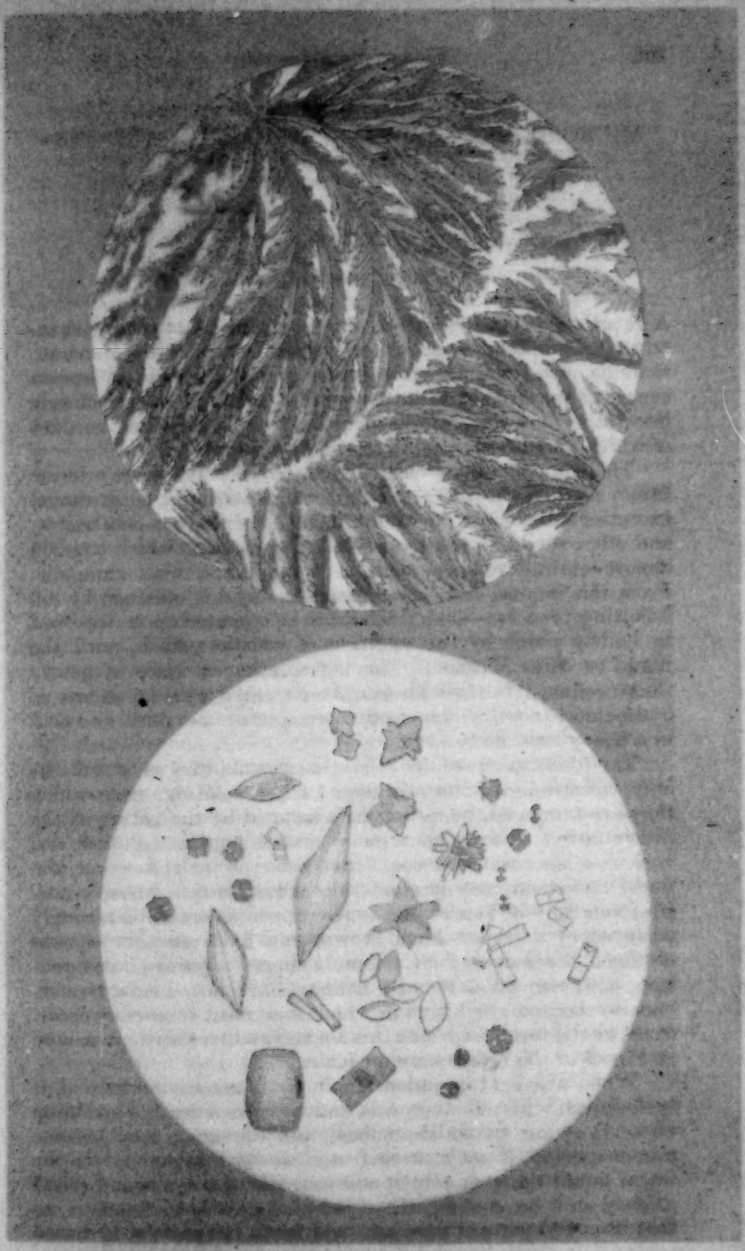
(*With a Tinted Plate.*)

A PAPER on Crystallization in the November part of the INTELLECTUAL OBSERVER, noticing the experiments of M. Kuhlmann, reminds me of a remarkable group of salts, very little known except to purely medical or chemical students, but exceedingly interesting in a microscopic point of view, some short account of which may be acceptable to the general reader.

The compounds to which I refer are derived from uric (or lithic) acid, a substance met with abundantly in most animal excretions, but most plentifully in those of the boa constrictor, and other serpents, the semi-solid excrement of which consists almost entirely of this acid, in combination with ammonia. From this impure urate of ammonia the acid is obtained by the following process:—The material to be operated on is dissolved in boiling water by the addition of caustic potash, until the liquid becomes alkaline. The hot solution of urate of potash thus produced is then filtered, and treated with an excess of hydrochloric acid, which at once precipitates the pure uric acid in a heavy crystalline form.

The forms assumed by uric acid crystals vary very remarkably, according to the character of the solutions from which they are produced, being much influenced by the nature of the precipitating agent, the organic matter held in solution, and various other circumstances. Like other crystals, however, the finest specimens are produced the most slowly. Those occurring naturally in human and other secretions are often strongly coloured of a deep reddish brown, and have on this account obtained the name of "Cayenne Pepper" crystals, a designation, however, which may be held to have also a covert reference to the gouty subjects in which they most frequently occur. Some of the forms in which this acid crystallizes are represented at Fig. 2 of the accompanying plate.

When uric acid is added gradually to strong nitric acid, it is dissolved with effervescence, and with considerable evolution of heat, owing to which, indeed, the operation may become unmanageable, if not cautiously and slowly conducted. In the warm liquid there shortly appear crystals of a compound called *alloxan* and, on cooling, these increase greatly in numbers, so that from 100 parts of pure uric acid, 90 to 105 parts of hydrated



MICROSCOPIC CRYSTALS

Oxalate of Ammonia. Tartaric Acid.

alloxan may be obtained. A solution of this substance stains the skin pink, but its crystals have no particular interest to the microscopist, and it is important chiefly as a stepping stone to the production of other compounds.

Alloxantine, a compound slightly different from the foregoing, is prepared by passing through the mother-liquor of alloxan a current of sulphuretted hydrogen gas, and by the action of ammonia on a solution of these two substances (alloxan and alloxantine) is formed one of the most splendid of chemical products, *murexide*, the crystals of which are beautiful objects for the microscope when viewed either by reflected or transmitted light. By transmitted light they are of a deep red colour, but by reflected light of a metallic green, very like that seen on the elytra of some insects, such as the Spanish blistering fly (*Cantharis vesicatoria*). In the preparation of the crystals of murexide, small quantities only of the required substances should be used, and for the precautions necessary both in this and other similar operations, as well as for full instructions as to their successful performance, the experimenter cannot do better than refer to Dr. Gregory's *Handbook of Organic Chemistry*. To give these details here would be tedious, and out of place.

Several other compounds of this series form excellent microscopic objects. *Alloxanate of ammonia*, when slowly crystallized, sometimes disposes itself in feathery forms of the most exquisite beauty: one of these is represented in Fig. 1. *Uramile* crystallizes in little feathery balls; *oxalurate of ammonia* in radiated hemispheres, and *thionurate of ammonia* in small rectangular plates; the two latter salts polarize beautifully.

One cannot but be struck with the similarity which many of these crystals bear to the lower forms of vegetable life. Those of uric acid, for instance, delineated in Fig. 2, must remind the microscopist of many familiar objects. The oval or "lozenge-shaped" crystals are very similar in form to certain diatoms, even to a median longitudinal fissure, seemingly splitting them into two valves. Others remind us forcibly of the Desmidiæ, especially of the genera *Micrasterias* and *Euastrum*, while we could scarcely have a more accurate or graceful idealization of some of the familiar red algæ than is presented in the crystallization of alloxanate of ammonia (Fig. 1). Even to the proliferous method of branching from the central midrib, this is wonderfully true to the sea-weed character. An artist might have designed it from the genus *Delesseria*, but would scarcely have produced a work at once so elegant and so vitally true.

Of course it may be said—perhaps truly said—that these resemblances are mere matters of coincidence. Certain it is, that though of constant occurrence, the laws which govern

their production are but very imperfectly understood. We are told that the arborescent forms assumed by hoar-frost are the result of markings of the surfaces on which it is deposited. Still, though such markings do influence the particular form assumed, they do not impress upon the crystals the *disposition* to follow curved lines and mimic the forms of vegetable life. We seem here to be on the confines of the organic and inorganic worlds. That the forces which govern both are identical, we are led, by the progress of science, each day to believe more strongly. That "vital force" itself will be found one day to be the simple result of more elementary forces—heat, light, and so forth—we can scarcely doubt. At present the term "vital force" is a mere cloak for our ignorance. To use the words of a contributor to the *Reader* (Oct. 29, 1864), "It is the compounding in the organic world of forces that belong equally to the inorganic that constitutes the mystery and the miracle of vitality. Every portion of every animal body may be reduced to purely inorganic matter. A perfect reversal of this process of reduction would carry us from the inorganic to the organic; and such a reversal is at least conceivable. The tendency of modern science is to break down the wall of partition between the organic and inorganic, and to reduce both to the operation of forces which are the same in kind, but whose combinations differ in complexity. The mode in which these combinations have been brought about is a perfectly legitimate subject of scientific speculation, and in this we will here so far indulge as to ask a single speculative question. It is generally supposed that our earth once belonged to the sun, from which it was detached in a molten condition. Hence arises the question, 'Did that incandescent world contain latent within itself the elements of life?' Or, supposing a planet carved from our present sun, and set spinning round him at the distance of our earth, would one of the consequences of its refrigeration be the development of organic forms? *Structural* forces certainly lie latent in the molten mass, whether or not those forces reach to the extent of forming a plant or an animal. All the marvels of crystalline force, all those wonderful branching frost-ferns which cover our window panes on a frosty morning, the exquisite molecular architecture which is now known to belong to the ice of our frozen lakes, all this 'constructiveness' lies latent in an amorphous drop of water, and comes into play when the water is sufficiently cooled. And who will set limits to the possible play of molecular forces in the cooling of a planet?" But even if we admit the soundness of these speculations, we must still look further backwards to "one Great First Cause," by whom are all things, and for whose pleasure "they are and were created."

NOTES ON SOME OF THE SMALLER RODENTS FOUND IN NORTH-WEST AMERICA.

(*Continued from No.* 36, *p.* 422.)

BY J. K. LORD, F.Z.S.,

Late Naturalist to the British North American Boundary Commission.

THE APLODONTIA LEPORINA (Rich.).

SEWELLEL OR SHOW'TL OF THE NESQUALLY INDIANS.

Synonymes.

Aplodontia leporina, Rich., F.B.A. i., 211, plate xviii.; And Bach. N. A., Qua. iii., 1853, 99, pl. cxxiii.
Hoplodon leporinus, Wagler System, Amh., 1830.
Anisonyx rufa, Rafinesque Am. Month. Mg. ii., 1817.
Arctomys rufa, Harlan F. Am. 1825, 308.
Sewellel, Lewis and Clark's Travels, ii. 1815, 176.

General Dimensions.—Nose to ear, 2 in. 7 lines; nose to eyes, 1 in. 5 lines; tail to end of vertebræ, 9 lines; tail to end of hair, 1 in. 2 lines; ear, height, 5 lines; nose to root of tail, 14 in. 6 lines.

My first introduction to this rare and curious little Rodent was on the bank of the Chilukweyuk river. My canvas house was pitched in a snug spot under the shade of a clump of cotton-wood trees, that grew close to a stream, that like liquid crystal, rippled past in countless channels, threading its way between massive boulders of syenite, and trap, and granite, and green-stone, that had been rounded and polished till they looked like giant marbles. But is not every one of these stones a silent record, a history in itself, of the terrible force of the summer floods? A few short months ago and this tranquil stream was a roaring muddy torrent, fed by melting snow. Endowed with freedom, what can resist the force of water? Rocks, and stones, and gravel, and mud, are dragged slowly along, grinding their predecessors as they go, until they come into the light again on the subsidence of the flood, and rest, as do these worn veterans, far from their mountain home.

Towering up behind me were the Cascade Mountains, their snow-clad summits dim in the haze of distance, their craggy slopes split into chasms and ravines, so deep, and dark, and lonesome, that no man's footfall has ever disturbed their solitudes; so densely wooded up to the very snow-line with pine, and cedar, and spruce-trees, that not even a bare rock peeped out to break the sombre monotony of the dark green foliage.

Before me, stretching away for about three miles, was

an open grassy prairie, one side of which was bounded by the Chilukweyuk river, the other by the mighty Fraser. At the junction of the two streams, at one angle of the prairie, stood an Indian village—the rude plank sheds and rush lodges, the white smoke curling gracefully up through the still atmosphere from many a lodge fire, the dusky forms of the savages, as they lolled and strolled about in the fitful light, gave life and character to a scene indescribably lovely.

The Chilukweyuk river heads from a large lake situated high up in the mountains, and without exception one of the most beautiful lakes I ever beheld. It is completely built in on all sides by vertical walls of trap and granite rock, and so precipitous and impassable, that when marking the boundary line, we were compelled to build scows, a rude kind of vessel, half raft, half boat, to cross over the mules, stores, and provisions, it being quite impracticable to make a road or trail on either side of the lake.

Filling up a gap between two rocky peaks is a vast glacier, that one might easily imagine a mass of brilliant beryl. The Indians say it was once another lake, but so many bad spirits lived in it, that Swa-nea, their grand saint, suddenly turned it into crystal, and all the wicked ones are shut up in it now. Numerous small streams trickle into the upper end of the lake, but the lower angle is dammed in by masses of rock, through which is a split or chasm, as if rent by some terrible force. Through this gap escapes the entire river; onward it goes, down the mountain gorge—leaping from rock to rock, it neither rests nor tarries in its headlong course, until stealing out from the dark shadow of the forest, it saunters idly along through the waving prairie grass, to mingle its waters with the Fraser, and with it to journey seawards.

The Indian summer was drawing to a close, the maple, the cotton-wood, and the hawthorn, fringing the winding water-ways, that, like silver cords intersected the prairie, had assumed their autumn tints, and, clad in browns and yellows, stood out in brilliant contrast to the green of the pine forest. The prairie looked bright and lovely, the grass, as yet untouched by the frost fairy's fingers, waved lazily, wild flowers of varied tints and species peeped out from their hiding-places, enjoying to the last the lingering summer.

I had been for some time sitting on a log admiring the sublime beauty of the scene spread out before me like a gorgeous picture, the sun was fast receding behind the hill-tops, the lengthening shadows were fading and growing dimly indistinct, the birds had settled down to sleep, and the busy hum of insect life was hushed. A death-like quiet steals over every thing in the wilderness as night comes on, a stillness that is

awful in its intensity, such as I have never realized but in the solitudes of an unsettled country. The sound of your own breathing, the crack of a branch, a stone suddenly rattling down the hill-side, the howl of the coyote, or the whoop of the night owl, seems all intensified to an unnatural loudness. I know of nothing more appalling to the lonely wanderer camping by himself than this "*jungle silence*," that holds supremacy through the weary hours of the night.

This silence was suddenly broken, as was my reverie, by a sharp ringing whistle; it was so piercing and clear that I could not believe it was produced by an animal. It had hardly died away, when another whistler took it up, then a third, and so on until at least a dozen had joined in the chorus. I stole as carefully as I could in the direction from which the sounds came, but as I neared the spot the whistle ceased, and it was now far too dark to descry any object on the ground. So, in doubt, and sorely puzzled to account for such an unusual sound, and with a firm determination to unravel the mystery in the morning, I returned to my camp. Could it be Indians? No, impossible, there were far too many, and the tone of each whistle was precisely alike. I was equally sure it was not the cry of the rock whistler (*Actomys*), that sound I knew too well. What could it be?

As the grey light of the morning came peering into my tent, I started off to investigate the secret of the mysterious whistler; but all I could discover, after a long and diligent search, was, that there were numerous runs and burrows excavated in the sandy banks of the river, but by what sort of animal I could not for the life of me guess. Setting a steel trap at the entrance to one of the holes, I strolled down to the Indian village, thinking I should possibly be able to find out from the Red-skins what it was that made such shrill sounds. Partly by signs, and by using as much of their language as I at that time knew, I endeavoured to make the old chief comprehend my queries.

After attending to my frantic attempts to produce a ringing whistle by placing my fingers in my mouth, and blowing through them until my face was like an apoplectic coachman's, a smile of intelligence lit up his swarthy visage; then I set to violently digging imaginary holes, and explaining that the sounds came about twilight, he nodded his head, dived into the tent and disappeared in the smoke, but shortly emerged again with a rug or robe made from the skins of an animal that was quite new to me.

It was beautifully soft, glossy, brown. The skins were about the size of a large rat's, and about twenty in number. Here, then, was the dawn of a discovery. He called the animal

Ou-ka-la, and made me understand that it lived on roots and vegetable matter, and burrowed holes in the ground.

As the daylight faded out, I again took my seat, and just as before, when everything was silent, the woods echoed with the Ou-ka-la's cry. I longed for morning, and hardly waited for light, but hastened off to my trap, and, joy of joys, I had him sure enough, caught by the neck. Poor Ou-ka-la, your friends had heard, and you had given, your "last whistle." He was dead and cold, trapped, perhaps, whilst I listened, wondering, keeping my lonely vigil. A very brief examination revealed the fact that I had caught a magnificent specimen of the *Aplodontia leporina*, of which I had only read.

Captains Lewis and Clark obtained some vague information about this animal, which is given in their journal of travel *Across the Rocky Mountains*, in 1804. All they say of its habits is, "that it climbs trees and digs like a squirrel." They obtained no specimen of the animal, but saw, probably, robes made of the skins. It was subsequently described by Rafinesque, and by him named *Anisonyx rufa*, and by Harlan *Arctomys rufa*. In 1829 Sir John Richardson obtained a specimen, and after a careful anatomical examination, this eminent naturalist determined it to be a new genus, and re-named it generically and specifically. The generic name Aplodontia is founded on its having rootless molars, or grinding teeth, *απλοος*, *aploos*, simple; *οδους*, *odons*, a tooth. It belongs to the subfamily Castorinæ; dental formula $\frac{2}{2}\ \frac{0\,0}{0\,0}\ \frac{4\,4}{4\,4}$ 22.

Sp. ch.—Size that of a musk rat; tail very short, barely visible. Colour, glossy blackish brown. Male, length about 14 inches; female, resembling the male, but smaller. The fur is dense and woolly, with long bristly hairs thickly interspersed; the short fur is blueish grey at the base, the ends of the hairs being tipped with reddish brown; the bristles are black, and when smoothed give a lustrous appearance to the fur. The eyes are very small, and placed about midway between the nose and the ear. The whiskers, stiff and bristly, are much longer than the head, and dark grey. The ears are covered on both sides with fine soft hair, rounded, and very short, and not unlike the human ear in shape.

Skull.—The skull is much like that of the squirrel's, with the marked exception of having rootless molars, and the absence of post orbital processes; the occipital crest is well developed, the muzzle large, and nearly round. The bony orbits are largely developed; the auditory bullæ are small, but open at once into wide auditive tubes; the first molar is unusually small, oval, and situated against the antero-internal angle of the second; all the molars are rootless; the lower grinders are much like the upper, but somewhat longer and

narrower. The molars in both jaws are situated much further back than is usual; the centre of the skull being about opposite to the meeting of the second and third. The lower jaw is very singularly shaped, the inner edges of the molars on opposite sides being parallel; the descending ramus is bent, so as to be exactly horizontal behind; the postero-inferior edge, being a straight line, nearly perpendicular to the vertical plane of the skull's axis. The conformation of the incisor teeth is admirably adapted to the purposes they have to fulfil; no carpenter's gouging chisels are more effective tools than are these exquisitely constructed teeth. It is essential that they should always have a sharp, cutting edge, in order to nip through the tough vegetable fibre on which the animal subsists; at the same time strength and durability are indispensable. The Aplodontia has no whetstone, or quadrupedal razor-grinder, to sharpen his tools when they grow blunt; but an all-wise foreseeing Providence has so fashioned these wondrous chisels in all Rodents, that the more they are used the sharper they keep; the contrivance is as simple as it is beautiful. The substance of the tooth itself is composed of tough ivory, but plated on the outer surface with enamel as hard as steel. The ivory being the softer material of course wears away faster than the enamel, hence the latter, plating the front of the tooth, is always left with a sharp cutting edge. Where could we find a more striking evidence of design and forethought!

The position this genus should occupy in a systematic arrangement of the Rodents has always been a stumbling-block and a matter of doubt, in great measure attributable to the fact that but a single species of the genus is known, and very few specimens have hitherto been obtained. A fine male specimen has recently been set up in the British Museum collection, that I caught near my camp on the prairie.

In many particulars the Aplodontia very nearly resembles the Spermophiles, particularly the Prairie Dog (*Cynomys Ludovicciana*), but differs, as in the true squirrels, in the rootless molars and the absence of post orbital processes. In this respect it is allied to the beaver. It is quite impossible to assign it a well defined and settled position, until a greater number of specimens are procured, from which more minute and careful examination of the bony and internal anatomy can be made. At present, however, it would appear to connect the beavers with the squirrels, through the Spermophiles. All hitherto known about its habits is the quotation from the journal before mentioned.

The name Lewis and Clark gave this animal, *Sewellel*, is evidently a corruption of an Indian word. The Chinook Indians are a powerful tribe living near the mouth of the Columbia, and

from whom, in all probability, Lewis and Clark obtained the name, and first heard of the animal. But the Chinook name for the Aplodontia is Og-ool-lal, Shu-wal-lal being the name of the *robe* made from the skins; and this is unquestionably the word, corrupted into *Sewellel*, and misused as the name of the animal. In Puget's Sound the Nesqually Indians call it Show'tl; the Yakama Indians, Squal-lah; the Sumass, Su-ok-la.

A single glance at the conformation of the feet would at once convince the most careless observer that climbing trees was not a habit of the Aplodontia. The feet and claws are digging implements of the most finished and efficient kind; the long scoop-shaped nails, like garden trowels, wide strong foot, almost hand-like in its form, the strong, muscular arms, supported by powerful clavicles, proclaim him a miner; his mission is to burrow, and most ably he fulfils his destiny. His haunt is usually by the side of a stream, where the banks are sandy and the underbrush grows thickly, his favourite food being fine fibrous roots, and the rind of such as are too large and hard for his teeth. He spends his time in burrowing, not so much for shelter and concealment, as to supply himself with roots. He digs with great ease and rapidity, making a hole large enough for a man's arm to be inserted.

In making the tunnels he seldom burrows very far without coming to the surface and beginning a new one. Like a skilful workman, he knows how to economise labour; having to back the earth out of the mouth of the hole he is digging, the further he gets in the harder grows the toil, and so he digs up through, and starts afresh. They seldom come out in the daytime, and I have but rarely heard them whistle until everything was still, and the twilight merged into dark night.

The female has from four to six young at a birth, and they have about two litters in a year. The nest for the young is much like that of the rabbit, made of grass and leaves, and placed at the end of a deep burrow.

In the winter they only *partially* hybernate, frequently digging through the snow to eat the bark and lichen from the trees. Their gait when on the ground is very awkward, their broad, short feet are not fitted for progression, and they shamble rather than run, and can be easily overtaken. Where a colony of them has resided for any time, the ground becomes literally riddled with holes, and the trees and shrubs die for want of roots. I imagine, from having found abandoned villages, that they wisely migrate when their resources are exhausted. The Indians esteem their flesh a great luxury, and trap them in a kind of figure-of-four trap, set at the mouth of the burrows. I dare say they are as good as a rabbit; still, they have too rat-like

an appearance to possess any gastronomic attractions for me. Every one to his taste—*De gustibus non est disputandum.*

The Aplodontia has a terrible and untiring enemy in the badger (*Taxidea Americana*). He is always on the hunt for the poor little miner, and digs him out from his hiding places and devours him with as much gusto as the Indian. Its geographical range is not very extended, being, as far as I know, confined entirely to a small section of North-West America. I have seen it on the east and west slope of the Cascades, but not on the Rocky Mountains, although it very probably exists there. It is also found at Puget's Sound, Fort Steilacum, on the banks of the Sumass and Chilukweyuk rivers, West of the Cascades. On the Nachess Pass; at Astoria and the Dalls, on the Columbia. East of the Cascades.

I have thus endeavoured to jot down a few notes on the habits and localities of this curious Rodent. Feeding entirely on vegetable matter (for I never discovered a trace of insect or larvæ remains in its stomach), passing its life principally in dark burrows, and limited, as far as we at present know, to a very narrow section of a barren country, it is hard to imagine what purpose it serves in the great chain of nature, save it be that of supplying food to the badger, and both food and clothing to the savage; and yet we know that the all-wise Creator fashioned it, and gave it life, for some grand and specific purpose, if we could but read and rightly interpret the pages of nature's wondrous book. If we ask ourselves why was this or that made? how seldom can we, with all our boasted knowledge, answer the question. Why did He who made our world, the sun, and the stars, deck the butterfly's wing with tiny scales, that by a simple change in arrangement produce patterns beside which the most finished painting is a bungling daub? Why were those microscopic wonders, the diatoms and infusoria, formed with shells of purest flint, of the quaintest devices, but of mathematical correctness; atomies that fringe every frond of sea-weed, tenant every road-side pool, and are in countless millions in every berg and floe, that form banks hundreds of miles in length, and dance in myriad forms in every sunbeam? Why all the prodigal variety of strange forms crowding the sea—forms more wonderful than the poet's wildest dreams ever pictured. Who can tell? All mystery inexplicable; the further we wander into the enchanted labyrinth of life, the more we feel our own littleness, and learn this great truth, that all we see belongs not to us, but to One greater, and wiser, and holier; and amid all the stir, and hum, and bustle of nature's vast garden, in the babble of the brook, in the whisper of the breeze, we hear, as of old, "the word of the Lord God walking among the trees of the garden in the cool of the day."

ANIMALCULES IN THE WINTER.

BY PROFESSOR RYMER JONES, F.R.S.

It is but too generally taken for granted that during the winter months there is a suspension of activity in the world of animalcules, and we have not unfrequently heard our friends speak as hopelessly of obtaining Infusoria at Christmas for microscopical exhibition, as of gathering hedge-flowers and May-blossoms amid the snows of January. Indeed, were we to follow the directions usually given for their procurement, the one and the other would be equally unobtainable. Nevertheless, according to our own experience, winter is the very time for observing the infusorial races in their full luxuriance; at no other period of the year are certain forms of them so easily procurable. We well remember in our younger days sallying forth to Hampstead ponds or Blackheath, equipped with phials and ring-nets and dipping bottles *secundum artem*, and many a pleasant summer's day have we thus spent in vain endeavours to collect rare species, only obtainable, as we were then told to believe, in specified localities and at particular seasons. Experience has taught us better, and it will perhaps not only save our readers much valuable time, but ensure them a rich abundance of specimens of all kinds at any period, if they bear in mind the following circumstances in connexion with the natural history of the Infusoria generally. We have endeavoured to show in a former communication that infusorial animalcules are always to be found congregated in the vicinity of aquatic plants, many of them appearing to prefer certain forms of vegetation. It is not, however, with living, but with decaying vegetable matter that they are associated; it is upon the effete elements of plants that they feed, the rotting atoms just about to decompose afford them nourishment, they seize upon the macerated tissues of vegetables whilst they are still organic particles, and before they disband themselves into their component gases, restore them to the cycle of organized existences. Far from perishing with the plants upon which they seem to live, it is only by the death and decay of the vegetable world that they are called forth in full force and activity; and it is more especially during the winter, that is, when rotting leaves and decaying plants encumber the bottoms of our ponds, when the "fat weed" dissolves itself to slime, and the tissues of perishing vegetation are diffused through the mud and sediment of the pool, that they can be obtained in their greatest variety.

With this insight into the habits of the Infusoria, the micro-

scopist will find no difficulty in supplying his winter evenings with materials for observation. Furnished with an ordinary ring-net of muslin and a wide-mouthed bottle, he has only to proceed to the nearest pond (no matter if the ground be covered with snow, or the pond frozen over, so long as the ice is breakable) and there fish up from the bottom a few of the dead leaves, bits of pond-weeds or any similar remnants of vegetation, and having thus half filled his bottle with most worthless-looking scraps, let him fill it up with the pond water, and return in full confidence that he has not laboured in vain. Arrived at home, let him immediately procure three large tea-cups, into one of which, having well shaken his bottle, he must pour its fluid contents and allow it to stand for *one* minute, so that the thickest sediment may subside. At the end of *one* minute let him pour two thirds of the contents of the first cup into the second, and there allow it to stand for *two* minutes for the subsidence of its sediment, and then without delay, without shaking it, pour half of the contents of the second cup into the third. The cups may now be left to stand till the supra-natant water is clear, and the animalcules have all settled to the bottom.

On taking up with a dipping-tube a little of the sediment thus deposited, and submitting it to microscopical examination in a live-box, or upon a glass slide covered with a plate of thin glass, we have never yet been disappointed at the result. The sediment of our ponds and ditches seems indeed in winter time to be one vast nursery, in which are cradled all the families of microscopic life, the very metropolis of the race; and it is only by seeking them in this their retirement, that many interesting forms are obtainable with any degree of certainty.

Let us, however, place upon a slide a few drops of the deposit from our second tea-cup, procured, in the manner above described, from the Serpentine in Kensington Gardens, at this moment (January 2nd) partially frozen over, and covering them with a circle of thin glass, examine them with a $\frac{1}{4}$-inch objective. The peculiar aspect of the contents of our slide, as compared with the well-known products of the pond in summer time, is at once strikingly evident—the colours of decay predominate throughout, all wears the livery of the sere and yellow leaf—the very Confervæ seem as if they had been bleached with chlorine, and a few ragged masses of semi-decomposed vegetable tissue tangled in slimy patches constitute, as a painter would say, the still life of the picture. And yet amid the desolation of the scene, the concourse of actors is quite as great as the dimensions of the stage will permit, and we at once perceive that a very pretty pantomime is in process of performance. *Naviculæ* of every form and size are

sailing in little fleets to all points of the compass. *Baccillariæ*, in sufficient diversity to satisfy Ehrenberg himself, are shooting forth their intersliding rods, or splitting themselves into all sorts of zig-zags. Various species of *Gomphonema*, *Echinella*, and *Cocconema*, borne upon thread-like stems, are conspicuously beautiful among hosts of *Diatoms* and *Desmideæ*, while here and there an isolated *Closterium* or *Micrasterias*, the only green objects in the wintry landscape, shine forth like little emeralds set in silver.

To those who are only familiar with the spring or summer scenery of the microscope, this almost total absence of green is a very remarkable feature; chlorophyll has evidently become a scarce article, and the whole tribe of vernal forms, so beautifully coloured by its presence, are here deficient. *Euglena*, *Astasia*, *Pandorina*, *et hoc genus omne*, are sought for in vain, although the *Volvoces* are represented by a pallid, unhealthy-looking specimen of *Sphærosira*.

The Rhizopods are few and far between, a single specimen of *Actinophrys sol* seeming to have become bewildered in the crowd. The ciliated Infusoria, as regards the number of individuals present upon the stage, are much fewer than would be met with in summer under the same circumstances—the transparent nymphs of the *corps de ballet*, with their bewildering maze of fantastic evolutions, have given place to less numerous, but more important-looking characters in the masquerade. *Trichodina*, under the aspect of a gold-fish globe of the clearest jelly, ornamented internally with coloured bonbons, is actively pirouetting with *Coleps*, in the shape of a drunken beer-barrel; while an animated plum-pudding (*Bursaria*), dances a Scotch reel with half-a-dozen *Cyclidia*, having very much the appearance of transparent mince-pies, during which evolutions various forms of *Leucophrys* and *Paramecium*, easily recognizable as masters of the ceremonies, glide actively from place to place as if they were doing the polite to the whole party.

Nor are the Vorticellians to be omitted from our list of this goodly company. Of these, several beautiful arborescent forms (*Epistylis*, *Zoothamnium*) content themselves with gracefully bowing and curtseying to each other like belles of dignified deportment, while their brothers, *Vorticella cyathina*, much more jovially disposed, seem with uplifted glasses to be drinking to each other's health, until, unfortunately for them, just as they raise their wreathed cups for "one cheer more," a blue-looking Stentor (*Stentor cæruleus*) rushes right into the middle of them, upsetting the whole group, and raising such a commotion, that a dozen stewards of the ball might try in vain to re-arrange the dispersed dancers. Still, however, the

masquerade goes on with unabated spirit; a couple of water-bears, as they are well named by our German friends, or water sloths, as the French call them (*Tardigrada*), next enter upon the scene, looking for all the world like their quadrupedal namesakes, provided with a double set of legs, and, instead of toes, furnished with formidable-looking hooks, by the aid of which they rake and claw themselves into the middle of the motley assemblage with most unwieldy perseverance. In another part of the stage we see the empty skin of a Lynceus, in one corner of which a Swan animalcule (*Trachelocerca olor*) has ensconced himself, and where he seems to be amusing the company by enacting such a series of performances as we never before witnessed. It is difficult to say which is most wonderful, the amazing extensibility, flexibility, and contractility of his neck, or the activity with which he plies it in every possible, and apparently impossible, direction. Imagine a swan seated in one corner of the floor of a large drawing-room, suddenly shooting out its neck to the opposite corner of the ceiling, and from thence extending it along the whole length of one side of the room, like a great Plesiosaurus with a boa-constrictor for a neck, brandishing its head with the velocity of thought, and then in a moment shrinking to its natural dimensions. And now a grand turmoil announces the approach of another visitor; in rush the chariot-wheels of *Brachionus pala*, closely followed by one or two of his rotiferous brethren clearing away everything before them, tumbling the poor Swan animalcule and his fantoccini performance into a whole chaos of struggling atomies, and thus effectually stopping his indescribable exercise. No sooner have the Rotifers steamed out of sight than in glides a young *Planaria* clad in a coat of living velvet, the transparency of which permits you to admire the smallest details of his inmost structure. Not much lack of amusement here, we thought, as the departing skirts of the last arrival seemed to wave their adieux. What will come next? The question was at once answered by a lively little Naïs, whose black eyes suddenly peeped out from beneath a moving heap, from which she soon emerged, when, unfortunately, just as we were bringing her into focus, a couple of eel-lets (*Anguillula*), apparently feeling themselves incommoded by the crush, began to fight their way out of the crowd, and the curtain fell amid a scene of riot and confusion seldom witnessed within the walls of a theatre.

From the above list of the occupants of a single slide, which, however jokingly drawn up, is strictly accurate in its details, it will be perceived that, during the winter months, the animalcule inhabitants of the waters around us are by no means asleep. The Infusoria neither perish during the inclement

season, nor do they hybernate, but, on the contrary, are in a much better condition for microscopic observation than during the summer. The forms which chiefly occur are most of them of large dimensions, and living, as they appear to do, principally upon the transparent glair produced from decomposing vegetables, exhibit a clearness and translucency which is unusual at other seasons, and hence they may be fed with carmine or indigo under peculiarly favourable circumstances. In the Naïdes, the Planariæ, the Rotifera, and the Entomostraca, this glassy transparency is still more remarkable. Their alimentary canal appears completely emptied of all opaque particles, and their bodies are entirely destitute of oil globules, so that the details of their anatomy are traceable with extraordinary clearness, and moreover, the frequent occurrence among them of strange-looking creatures, evidently larval conditions of other forms of life, is well calculated to stimulate the curiosity of the observer whose time and opportunities permit him to enjoy the pleasure of watching their development.

DIFFRACTION EXPERIMENTS.

THERE are no experiments in optics more brilliant and beautiful than those which illustrate the effects produced by what is called the Diffraction of Light, a term which etymologically indicates a bending of the rays out of their course, and also a certain division or separation of them. The name is not perhaps very happily chosen, and M. Babinet in explaining certain phenomena of diffraction uses the term *paragenie*, or lateral propagation. The precise nature of the action that takes place in cases of diffraction can only be understood by those who are capable of following the mathematical illustrations given in such works as Sir John Herschel's *Treatise on Light*. It is, however, possible to explain enough of the matter to give the general reader a notion of the subject, correct as far as it goes, and which, without attempting to elucidate the intricacies of the question, will augment the interest to be derived from contemplating a series of easily obtained and splendid effects.

First, let us take from Sir J. Herschel a diagram showing what occurs when a ray of light strikes against the edge of an opaque object, and also quote from him a passage describing the action. He says: "When an object is placed in a very small beam of light, or in the cone of rays diverging from an extremely small point, such as a sunbeam admitted through a

pin-hole into a dark chamber, or, still better, through an opening of greater size, behind which a lens of short focus is placed so as to form an extremely minute and brilliant image of the sun, from which rays diverge in all directions, its shadow is observed to be bordered externally by a series of coloured fringes, which are more distinct the smaller the angular diameter of the luminous point, as seen from the object. . . . To see the fringes in question, they may be received on a smooth white surface." M. Fresnel, Sir John tells us, first used an emeried glass plate to receive the fringes, and looked at them through it from behind. He then found that when he had focussed them with a magnifier they continued visible, as if drawn on the air, when the plate was removed. The first thing to be noticed is "that the distance (of the fringes) from each other, and from the border of the shadow, diminishes as the screen on which they are received approaches the border of the opaque body, and ultimately coincides with it." The second important thing to be noticed is, "That they are not propagated in straight lines from the edge of the body to a distance, but in hyperbolic curves, having their vertices at that edge, and therefore it is not *one and the same* light which forms one and the same fringe at all distances from the opaque body." In the diagram subjoined, Fig. 1, "O is the luminous point, A the edge of the (opaque) body, and G H a screen perpendicular to the straight line O A; C the border of the visible shadow, and D, E, F, the places of the successive minima of the fringes in a line at right angles to the edge of the shadow. If the screen be brought nearer to A as at *g h*, and if *c*, *d*, *e*, *f*, be the points corresponding to C, D, E, F, their loci will be the hyperbolas A*c* C, A*d* D," etc. The diagram shows that the rays behave as if they were so repelled from A as to oblige them to continue their path in a curve instead of going straight on from A to B. The result of this is that shadows are seen where they would not occur if the light did move quite straight from A to B. "Newton found the shadow of a hair, $\frac{1}{80}$th of an inch in diameter, placed at twelve feet distance from the luminous point, to measure at four inches from the hair $\frac{1}{60}$th of an inch, or upwards of four diameters of the hair, at two feet $\frac{1}{18}$th of an inch, or ten diameters, while at ten feet it measured only $\frac{1}{8}$th of an inch, or thirty-five diameters, instead of 120, which it would have done if the rays terminating the shadow had proceeded in straight lines, or rather, to speak more correctly, if the shadow were

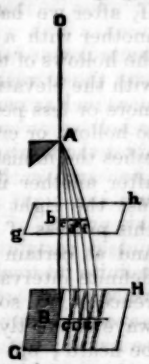


FIG: 1.

bounded by straight lines"* The investigations of Fresnel show that a strict application of the undulatory doctrine of light, assisted by the principle of interferences, will be found to afford a full and precise explanation of all the facts, regarding the opaque body merely as an obstacle *bounding* the waves propagated from the luminous point on one side."†

Let us now endeavour by appropriate analogies to obtain an elementary conception of light as a system of vibrations of a subtle fluid, or ether, and therefore bearing a certain resemblance to sound, or to water waves. It is easy to realize the fact that sound consists in vibrations and waves of air. The large strings of a harp or guitar may be seen to move when agitated so as to produce sounds, and various contrivances have been devised to make phenomena of this kind strikingly appreciable by the eye. When a stone is thrown into a still pond we have another illustration of wave forms, and we see them propagated in all directions, in circles increasing in dimensions, until the margin is reached. The most violent of these waves are those nearest to the stone causing the disturbance, and as they grow wider and act upon a greater breadth of water, they grow feebler likewise, until at last, if the pond be big enough, they die away in ripples too faint for observation. If, after we have set one series of waves in action, we start another with a different velocity, it will happen that some of the hollows of the first set will coincide more or less completely with the elevations of the second set; and when this occurs, a more or less perfect calm ensues, while the addition of hollow to hollow, or crest to crest, deepens the disturbance, and magnifies the miniature storm. If waves of sound are started one after another in due proportion, or if two sound waves, with just the right difference between them, be started together, this process of partial filling each other up may be produced, and at certain points of the wave march, corresponding with definite intervals of time, silence will result from the concurrence of two sounds. If at certain intervals the hollow of one wave is exactly filled up by the crest of another, no sound will be heard; but a partial filling up will modify the sound, and make it yield a different note. Much of the art of music consists in the production of well-managed interferences, giving rise to varied and highly pleasing effects.

If we pass from sound to light, we find ourselves able to produce bands of darkness by the interference of two rays of light. We can also devise methods of interference that shall give rise to modified waves having the dimensions necessary to excite upon our eyes the effects belonging to all the

* Sir J. Herschel's *Treatise on Light*, p. 480. † P. 481.

colours that we can see. The beautiful prismatic and other colours, to be obtained by means of the polariscope, and various bodies with which the microscopist is acquainted, are illustrations of one mode of obtaining chromatic effects by the interference of rays of white light. They depend upon refraction, and upon the path polarized light is able to take through crystals and other substances capable of affecting its velocity. Certain rays are bent out of their course, they are also more or less *dispersed*,* or resolved into prismatic rays, and these rays caused by further refraction to meet in certain directions, and with certain velocities, interfere with each other, and make the gorgeous colour pictures in which the microscopist delights.

If we can obtain interference of rays by any other means, we shall produce dark bands, or coloured bands, according to the circumstances of the case.

The extreme red ray of the solar spectrum is produced by undulations so numerous that, according to tables given by Sir J. Herschel, 37,640 of them only occupy one inch, and 458,000,000,000,000 occur in one second. These rays are, however, large in the length of their undulations, and slow in their movements compared with those of the extreme violet end of the spectrum, in which 59,750 undulations only occupy one inch, and take place at the rate of 727,000,000,000,000 in one second of time.†

Bearing in mind these considerations, let us now borrow another diagram from Sir J. Herschel to show a simple case of interference resulting from a wave of light being partially obstructed by a narrow opaque body. O, Fig. 2, is a needle-hole, through which a small sunbeam is allowed to pass; A B is a strip of card, which, in the experiment performed by Dr. Young, was $\frac{1}{50}$th of an inch wide; E F, its shadow. Let the reader forget for a moment the obstacle C D, which is wanted for a subsequent experiment. A B will then be the only obstacle in the way of light getting from O to any point between E and F. If we take the centre, X, it will be plain that the light that reaches it will result from the spreading portions of the wave passing the points A and B, and as each extends laterally, they will meet at X with equal velocities,

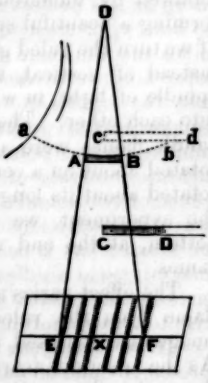


FIG: 2.

* See paper on "Spectroscope Apparatus," No. 34.

† These numbers will be slightly altered by the last estimation of the velocity of light.

and having made their journeys in precisely the same time; but undulations extending from F towards E will meet other undulations that started at the same time, but reached E quicker than those that came round the other corner. These will interfere and give rise to dark or coloured bands, according as their interference is complete or only partial. Dr. Young introduced the screen C D to cut off the undulations that passed B, and by so doing he stopped the interferences, and no fringes appeared.

We have thus arrived at a general explanation of why dark lines appear when white light is viewed through a very narrow slit, cut in a piece of metal or card.

If, instead of such a slit, we obtain a piece of glass ruled with fine lines, a five hundredth or a thousandth of an inch apart, the flame of a candle seen through them offers a splendid spectacle. A glass of this description, ruled very beautifully by Messrs. Horne and Thornthwaite, is in our hands at this moment; we hold it near the eye, so that the lines are vertical, and look at a candle-flame a few feet off, or at the sky in the day time. The candle-flame is seen in its natural colour in the centre, then on each side of it a dark space, and after that, in succession, right and left, a number of images of the flame in prismatic colours, the reds being always furthest from the central flame, and the blues nearest to it. The first few of these coloured images of the candle-flame are separated by considerable though lessening dark spaces from each other, and they are followed by numerous other images, running together, and forming a beautiful spindle-shaped pattern of variegated light. If we turn the ruled glass round, so that the lines are *horizontal* instead of vertical, the candle-flame gives us a continuous spindle of light, in which the several images of the flame run into each other. The optical effect is as if a number of coloured candle-flames were all fixed to a sort of a windmill arm and rotated about on a central axis, and at the same time each flame rotated about its long axis, so that whereas, at the beginning of the experiment, we saw its breadth and depth from top to bottom, at the end we see little more than the tips of the flames.

The effect varies according to the distance of the candle-flame from the ruled glass. Close to the flame the coloured images are confused, near each other, and deficient in brilliancy. As the spectator (carrying the ruled glass with him) recedes from the flame, the coloured images grow brighter, and separate from each other, and after they are thus separated, to a certain extent, revolving the ruled glass ceases to change the *form* of the pattern, as just described, and merely causes the spindle of coloured light to revolve. Eight and twenty feet off

a candle-flame, we see, with the particular ruled glass employed, a luminous coloured spindle about eight feet long.

For the next experiment we take a piece of blackened card and cut a thin slit in it. We hold this in one hand near the candle, and look at the light through the ruled glass, with the lines and slit both *vertical*. We have now an exquisite ribbon, composed of dark spaces and coloured light spaces arranged as before. If we keep the ruled lines in this position, the diffraction light ribbon will be at right angles to them, and as we revolve the slit, the ribbon will seem to turn so as to present itself alternately edgewise and full front. If we keep the slit still, and revolve the ruled lines, the ribbon of parti-coloured light will appear to experience two motions: one round and round, like a windmill arm, and the other the kind of revolution just described, giving us sometimes an edge view and sometimes a full view of the coloured stripes.

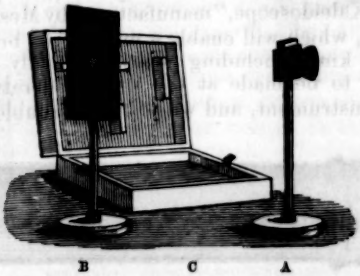
Mr. Slack has devised a very simple apparatus, the "Diffraction Kaleidoscope," manufactured by Messrs. Horne and Thornthwaite, which will enable a number of brilliant experiments of this kind (including many originally performed by Frauenhofer) to be made at the very moderate cost of purchasing the instrument, and without any trouble.

THE DIFFRACTION KALEIDOSCOPE.

The Diffraction Kaleidoscope consists of a tube, at one end of which is a revolving eye-piece, and at the other a revolving holder of discs of blackened card having certain apertures through which light is permitted to enter. The experiments just mentioned may be best performed by this instrument. A card disc with one pin-hole in the centre is placed in the disc holder, and an eye-piece containing a "grating" or ruled glass is slipped on to the opposite end of the tube. On looking through this at a bright light, obtained in the daytime from the sun or sky, and at night from any good lamp, effects like those just alluded to as seen with candle flame, may be observed. After witnessing the actions of one "grating," and one source of light, a second grating may be imposed over the first and at right angles to it. A brilliant chromatic star will then appear, with four principal rays, and other intermediate rays, which become conspicuous in proportion to the brightness of the light. The

second grating should then be removed and the effect of the *slit-disc* observed, first with one and then with two gratings. By holding the tube in the middle, either the eye-piece or the disc holder may be rotated separately as desired.

If a disc pierced with symmetrically-arranged holes in a circle about the size of a shilling, is employed, a very striking effect of perspective is noticed. The holes are really in one plane at right angles to the eye of the spectator; but when one grating is employed, each hole is seen in the centre of a spindle of many coloured light, and all the spindles seem arranged on a *horizontal cylinder*, so that when one of them looks exactly before the eye, and near it, another seems precisely behind the first and farther off. As the disc holder is rotated, the cylinder of spindles revolves, each spindle alternately approaching and receding from the eye. When one spindle looks exactly behind another, it is impossible to avoid the illusion that its light is



A. Holder for ruled glass, etc. B. Screen. C. Box holding apparatus.

literally seen through the light of the other. A singularly beautiful addition to the effect is obtained by the use of the second "grating" at right angles to the first. The rotation of the disc holder then gives the spectacle of two cylinders of spindles rotating at right angles to each other, and crossing their lines of light in a magical way.

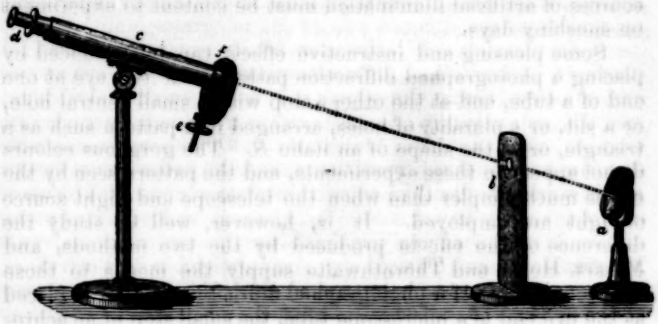
Instead of the disc of pin-holes in a circle, another disc with a large central hole and smaller ones removed from it may be used. This planet and satellite disc is very fine in its effects, especially when the slender light spindles afforded by the small holes appear to be behind and seen through the big spindle which the large hole gives rise to. Holes arranged in a triangle are likewise interesting; but any one who possesses the "Diffraction Kaleidoscope" can vary the patterns of the discs with no more trouble than piercing some discs of blackened card.

When the disc with pin-holes in a circle is used with two

"gratings," the revolutions of both gratings (without changing their relative position to each other) gives the appearance of double motion in each cylinder of light spindles; but if the outer grating is revolved while the inner one is stationary, one cylinder of spindles remains fixed and the other goes round.

Some experiments with gratings require the power of varying the distance of the source of light. For these Messrs. Horne and Thornthwaite have arranged a commodious apparatus, as shown in the cut on the preceding page.

The next apparatus for diffraction experiments which we shall describe, is the beautiful one exhibited at the scientific soirées of last season, by Messrs. Horne and Thornthwaite, and to which allusion was made at the time. This consists of a small telescope mounted on a stand.



BRIDGE'S DIFFRACTION APPARATUS.

The object-glass is covered by an apparatus devised by Mr. Bridge, by means of which a disc of glass, on which a multitude of diffraction patterns are photographed, is made to revolve in a spiral, so that all the patterns in succession, from the centre to the circumference of the disc, can be brought into the field. The exquisite patterns of these discs were drawn and arranged by Mr. Bridge, and they offer a great variety of different curves, chequers, etc., etc. When the sun is shining, magical and lustrous chromatic effects are obtained by placing on a table or other stand, a dark screen, in the centre of which is a lens of short focus. A mirror behind the screen receives the direct sunlight and directs it upon the lens, as shown in the sketch. An observer a few feet off in front of the lens sees a most brilliant spot of intense light, and if this is focussed by the telescope, and the diffraction disc revolved, a succession of gorgeous effects delights the eye. Stars of greater or less complication, lines of parti-coloured

light in beautiful curves and angles appear in succession, and the astonishment is great to notice what kind of diffraction grating gives rise to such unexpected effects. If the principles explained at the commencement of this article have been apprehended, some notion may be formed of the way in which each dark space of a grating may be the occasion of interferences between waves of light spreading laterally and meeting with other waves that have traversed longer or shorter paths.

To use Mr. Bridge's apparatus at night, an electric or oxy-hydrogen lamp is necessary to develope the full splendour of the effects. If magnesium wire becomes cheap enough, it would do admirably, and be always ready. Some notion, though a feeble one, may be gained by the employment of an ordinary lamp; but those who have not the command of powerful sources of artificial illumination must be content to experiment on sunshiny days.

Some pleasing and instructive effects can be produced by placing a photographed diffraction pattern near the eye at one end of a tube, and at the other a stop with a small central hole, or a slit, or a plurality of holes, arranged in a pattern such as a triangle, or as the shape of an italic *S*. The gorgeous colours do not appear in these experiments, and the pattern seen by the eye is much simpler than when the telescope and night source of light are employed. It is, however, well to study the difference of the effects produced by the two methods, and Messrs. Horne and Thornthwaite supply the means to those who require it. If a photographed diffraction pattern is placed at the eye end of a microscope tube, the small stop of an achromatic condenser will do for a source of illumination at the bottom.

Mr. Bridge's apparatus gives the most splendid appearances when a sufficiently brilliant light can be obtained. The "Diffraction Kaleidoscope" has the advantage, that for its very important though more limited operations, it is always ready, and, like the ordinary Kaleidoscope, may be passed from hand to hand and pointed without trouble at any ordinary source of light. Other experiments are conveniently performed by aid of the other apparatus figured above.

MR. LASSELL AT MALTA.

Mr. Lassell has addressed a letter to the *Astronomische Nachrichten*, giving some account of his proceedings at Malta during the term of a three years' residence now drawing to a close. He describes his telescope—a Newtonian reflector—as mounted equatorially, in a manner generally resembling that on which his 9-inch and 2-feet telescopes were mounted, as described in the *Memoirs* of the Astronomical Society. "The aperture is nearly 4 feet. There are two large specula, respectively of the foci of 441·8 and 448·1 inches. They are about 4½ inches thick, and weigh separately about 2700 lbs. The length of the tube is 37 feet, and its diameter 4 feet 3 inches. It is a lattice or skeleton tube, made of flat bars of iron, joined (with spaces between them nearly equal to the breadth of the bars) by flange rings at convenient distances." The object of this construction is to avoid chimney currents in the tube. No roof covers the telescope; but the observer is placed in a tower, one or other of whose stories commands the eye-piece at any elevation required. The stories of the tower are 4½ feet square and reached by an internal staircase. The tower itself is carried round by a circular railway. It can also revolve on its own axis, and it has a radial motion to or from the telescope.

Instead of a driving clock, which Mr. Lassell considered would be inconvenient from the great weight of the apparatus, he has a system of wheel-work terminating in a fly-wheel and winch handle. By turning the latter exactly once in a second, any object is kept in the field, and a peasant can do this by accommodating his movements to the indications of a loud ticking clock. This motion can be stopped, accelerated, or retarded at pleasure, and not being at all laborious, "can be continued for hours without being oppressive."

"Attached to the regulating clock are two dials, the finger or index of one of them having a retrograde motion and the dial figured accordingly; while the other is direct. The first of course belongs to the eastern hour angle, which is constantly diminishing—the second to the western. Being set to the present hour angle at the commencement by the observer, if from clouds, or any other cause, the observation is interrupted, the assistant can, by mere inspection of the dial, bring up the telescope to correspond with it by another winch having a quick motion, without the observer having to descend from the tower, or interfere in any way."

Among the planets, Neptune has received Mr. Lassell's special attention, and he says "the known satellite is so well

seen, especially when more than 8 or 9 seconds central distance from the planet, even in bright moonlight, and without any extraordinary atmospherical circumstances, that I have arrived at the firm conviction that the planet is attended by no other satellite which will bear comparison in magnitude with the known one—not greater certainly than Dione or Rhea, among Saturn's satellites, bears to Titan. It may be indeed possible that a faint satellite several minutes' distant might exist, though I have no suspicion of any, and one so situated would be very difficult to recognise among the numerous minute stars which a telescope so large as this generally reveals."

Equally careful observations were made on Uranus, confirming the belief that this planet only possesses the two satellites first discovered by Sir William Herschel, and the others (interior) discovered by Mr. Lassell in 1851.

Mr. Lassell considers that "in all future treatises on Astronomy, the proper number of known satellites should be assigned to these two planets—namely to Uranus four, and to Neptune one."

To facilitate observations on Saturn, Mr. Lassell appends to his letter an Ephemeris of the five inner satellites of Saturn for February, March, and April, 1865.

A series of drawings of Mars during his late opposition was much interrupted, as the weather for two months (November and December) was "quite as unfavourable as it is usually in England at the same season."

A good many drawings have been made of remarkable nebulæ, including an elaborate one not yet finished of the great nebulæ in Orion.

ASTRONOMICAL NOTES.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

THE GREAT STAR OF 1572.

No one can peruse the account given of the Temporary Star of 1572 without a conviction that it was one of the most marvellous phenomena which the Creator has ever exhibited to the eyes of men. Its sudden apparition; its astonishing splendour, rivalling, in the opinion of Tycho Brahe, Venus at her maximum, and rendering it visible even at noon-day, and that at a period when there were no telescopes to point to its place, after the mode practised by Schmidt in our own days; its visibility to all eyes during seventeen months, precluding the possibility of deception; its invariable position with regard to the neighbouring stars, proving that, if not equally distant with them, it was far removed beyond the bounds of the solar system; its scintillating aspect, indicating, in all probability, the smallness of its apparent disc, and its community of nature with other stars; its change of colour corresponding with its regular decrease in magnitude—all these combine to place it in the highest rank of celestial wonders. And time, that has done so much to throw light upon other difficulties, has brought none to this. It is now indeed known that the phenomenon, though extremely rare, is not unique; twenty-one instances of temporary, as distinguished from periodically-variable stars, having been collected by the industry of Humboldt. These are chiefly from the Chinese record of Ma-tuan-lin; and some of them appear to rest on no good authority; but there can be no question as to the splendid star seen by Kepler in 1604, which almost equalled, and in the opinion of some surpassed, that of 1572, or that discovered by Hind in 1848, which, though far inferior in magnitude, exhibited the same character. It has, too, been suspected that such phenomena are periodical, and, if so, may be looked upon as extreme cases of variable light. The chief ground for this idea is the statement that new stars are said to have appeared in the years 945 and 1264 "between Cepheus and Cassiopea," a description which, allowing for the inaccuracy of ancient chronicles, might pass for the position of that in 1572; nor would the inequality of interval be a sufficient bar to the supposition, as similar irregularities are constantly occurring in the periods of variable stars. If this could be admitted, and a period of something more than 300 years be reckoned upon, it is plain that observers ought to be now on the look-out for its possible return. With this impression, Professor Argelander, of Bonn, one of the very

highest authorities in stellar astronomy, has recently directed attention to the subject. Forty years back he undertook an elaborate computation of its place from the measures of Tycho, which were taken with a sextant from eight neighbouring stars in Cassiopea. These, as compared with the observations of Bradley, W. Struve, Bessel, and Piazzi, give an average error of + 1m. 26s. in R.A., and — 13″ in Decl., an amount by no means discreditable to an instrument of comparatively rude construction, and employed only with the naked eye. Its place thus deduced will be, for 1865, R.A. 4h. 19m. 57·7s.—D.N. 63° 23′ 55″·4. Our own great computer Hind had found a result 3m. 10s. less in R.A., and 50″ less in Decl., a difference the cause of which could not be ascertained by Argelander without a fuller explanation of Hind's mode of procedure. But assuming the place as calculated by himself, Argelander remarks that D'Arrest has observed a star, numbered by him 129, so nearly in the right position (that is, R.A. 4h. 19m. 30s., D.N. 63° 22′·9), that the difference does not exceed the uncertainty of the old observations. This, of course, would not be surprising amid the richness of the starry heavens; but what has struck Argelander has been the circumstance that he had formerly, with the 8-foot transit-instrument at Abo, sought in vain for a star near this place, as well as subsequently (probably in 1849) with the meridian instrument at Bonn; and the question has arisen in his mind whether D'Arrest's star, estimated by him as of 10·11 magnitude, may possibly be that most wonderful phenomenon in a slowly-increasing stage. He therefore entreats astronomers, who may possess sufficiently powerful means, to keep watch upon this little star. It may be added that the sudden development of the phenomenon of 1572 (as well as of those of 1604 and 1848) furnishes no serious argument against its periodical character, for a great disproportion between the times of increase and decrease is not unfrequently associated with variable light, and in those less observant days the earlier stages of its visibility would naturally escape notice, till it became too conspicuous to be any longer overlooked. It is not impossible that the parallax and distance of this wonderful star might have fallen within the grasp of such instruments as we now possess; and it might even have exhibited a visible and measurable disc, though this is less probable from what is recorded as to the intensity of its scintillation. But should any recurrent or fresh development of this kind take place during the present generation, we may be sure that the spectroscope of Mr. Huggins will be tasked to the uttermost to ascertain its real character.

TWILIGHT.

The well-known director of the Athens Observatory, Dr. J. F. Julius Schmidt, has published a valuable memoir on the duration of twilight, and inquiries of a kindred nature. The paper is a long one, and full of laborious computations; but some of his conclusions possess considerable interest as well as novelty. The subject, which has been very little explored, and has received little illustration since the imperfect observations of Ptolemy and Alhazen, had attracted his attention for twenty years, but his experimental investigations date chiefly from February, 1856. His observations, which were very numerous, were spread over a zone reaching from N. lat. 53°·5 to 36°·5, but were chiefly made at Olmütz, in Germany (N. lat. 49° 35′·7), and Athens (N. lat. 37° 58′·3), where the purity of the sky afforded far greater facility, and where the subject was still further pressed upon his notice by a request from the Athenian Bürgermeister in connection with the lighting of the town by gas! (What would have been the astonishment of Pericles!) His memoir does not, however, treat of the termination of ordinary or civic twilight, when 6-mag. stars first become visible in the zenith, but of that of astronomical twilight, when the last trace of light vanishes from the horizon, the real night begins, and the sky over the coasts of the Mediterranean is granulated or powdered over with innumerable glimpses of stars of the 6 and 7 mag., too minute to be fixed by the eye. His observations were always made on the zenith, under which term he obviously includes a considerable extent of sky; and his conclusions affect not merely the maxima and minima of duration, but the height of the atmosphere, as far as its existence is thus rendered perceptible. He marked, of course, the progress of twilight by the successive appearance of stars of the first 6 mags.; but, by the term 1st mag. stars, he designates, otherwise than is usually done, the exceptionally bright ones, Wega and Capella, Sirius culminating too low at Olmütz on a lighter background, and Arcturus, though sometimes employed, being suspected by him of slowly variable light. How he classed the smaller stars, commonly reckoned as of 1st mag., does not appear. These great leaders, if watched for in the ordinary way, he thinks might be detected from 18m. to 70m. (probably a misprint for 20m.) after sunset; but if due preparation were made, by first finding the star in a telescope, and then looking along the outside of the tube as a guide, he found that stars of this brilliancy would come out very much earlier, though the practice was so trying to the sight that his results were not numerous. They are, however, very curious. He found that these large stars, thus hunted

out, became visible to the naked eye even before sunset. Sirius, for the reason given above, he thus saw only seven times; but another of his 1st mag. stars, when near the zenith (he does not specify which, but from the date, June, it must have been Arcturus), he actually perceived 24m. *before sunset*, and gives as the mean of such observations by a practised eye, 8m., when the centre of the sun is still 40′ above the horizon.* As to the smaller stars, he found that, at a mean, the sun's centre must sink respectively beneath it to 4° 18′, 5° 4′, 6° 50′, 8° 52′, and 11° 39′, in order to admit of those of the 2, 3, 4, 5, and 6 mags. becoming visible; a much smaller estimate, by 6° at an average, than that given by Wurm at the beginning of this century. The final extinction of horizontal twilight was not observed at Olmütz from the extreme rarity of suitable opportunities: at Athens its frequent observation presented no difficulty on that score, but was not easily accomplished, from a very different reason—the interference of the Zodiacal light, which is there never absent from the morning or evening sky, and disturbs the observation in different degrees, according to its varying brightness and inclination to the horizon at different times of year. It appears that the old observers could not have been misled by the presence of this phenomenon, from the very fair value, 18°, which they have assigned for the sun's depression at the end of twilight; but he justly thinks it extraordinary, considering the brightness and singularity of the appearance, that it should have been mentioned by no one before Cassini,† and conjectures that in old times it must have been either less brilliant, or else so familiarly known in more southern countries that no especial notice was taken of it. At the final close of twilight he found the depression of the sun beneath the horizon of Athens, Dec.

* The old story of seeing stars in the day-time from the bottoms of wells or pits is fully authenticated. I believe I have met with an account, which I cannot now verify, of Sirius having been traced for some time after sunrise by an old observer, probably Hevel. More to the purpose is Bond's statement, that he actually saw that star on one occasion when "the sun was high above the horizon and shining clearly;" and he adds, "from the readiness with which the latter could be discerned, in a position where much of its light must have been lost by atmospheric extinction, I should think it possible to see *α Lyræ* also under favourable circumstances."

† Who was the first discoverer of this phenomenon, the mystery of which seems to become more and more impenetrable, or rather, who first drew attention to it, seems uncertain. It has been said, but I know not on what ground, that Kepler has mentioned it. It appears from Hooke's Lecture on this "Glade of Light," read before the Royal Society, June 3, 1685, that Dr. Childrey's observation upon it, published in 1660, "was translated into *French*, and printed in the year 1667, as appears by the *Miscellanea Curiosa Academiæ Naturæ Curiosorum*;" and by that means the Advertisement was spread in *France* and the rest of *Europe*. Cassini, however, published his own observation of it in 1683 as an original discovery, and his high character affords a fair presumption that to the best of his knowledge it was so.

1st = 17°·7; June 1st or July 1st = 15°·3, and at a mean of the whole year, = 15°·92. His observations at Olmütz, though too incomplete to give anything like accurate results, sufficiently show that there are two *maxima* for the duration of twilight, corresponding with summer and winter, and two *minima*, in spring and autumn. The longest mean monthly interval between sunset and the appearing of the minutest stars was 106·3 minutes, occurring in June; the shortest, in January, 69·5 min. Similar *maxima* and *minima* were found to exist at Athens; the longest interval being, however, only 99·2 min., owing to the difference of latitude. He adopts Bauernfeind's recent value of the horizontal refraction, 34′·3, as more accurate than the formerly received one, 36′. The diminution of starlight from passing through the atmosphere, like that of the blue colour of the sky, he considered imperceptible as far as 50° or 60° from the zenith; but on the shores and islands of the Mediterranean days occur in which the blue tint reaches so completely down to the sea line that it is difficult to convince ourselves that the tone of the zenith is a little deeper; nights, too, when the stars preserve their brilliancy to 10° or 8° from the horizon. In the most transparent nights of Attica, he found that Jupiter, even when 86°·07 from the zenith, rivalled Wega overhead, and Arcturus had sunk to 82°·3 before it was reduced to equality with *a* Cygni near the zenith. His comparative values, taken at Olmütz, gave for the brightness of Jupiter 45·2; for Wega or Capella, 38·7; for Arcturus 36·1. From the habit of such investigations, when first he caught sight of Canopus, the glory of those skies which we never see, deep on the sea-horizon of the Isle of Cerigo, he concluded that it would at the zenith have exceeded Wega by two or three of the units of his scale. How that scale was constructed, he has not here given us any information.

From these researches, combined with barometrical and thermometrical investigations, Schmidt has deduced the height of the atmosphere, as far as it is made known to us by its action upon light, equal to 46 miles at Athens on January 1, decreasing, though not quite regularly, to 35 miles on June 1 and July 1. These values, he thinks, may probably have been augmented by refraction beyond their true amount; and he intends to prosecute the subject further. It is obvious that these inquiries must be materially affected by transparency of sky and keenness of vision; and when we find that within the "square" of Pegasus, Schmidt could count with the naked eye 102 stars at Athens, while Argelander at Bonn could detect barely 30, we may form some idea both of the extraordinary facilities afforded by the Southern heavens, and of the difficulty

of combining the observations which they yield so readily with those which are reluctantly given up by our more turbid skies.

SOLAR OBSERVATION.

But a few years ago it would have been difficult to realize the idea of a light exceeding the brightness of the sun. Its possibility must of course be conceded; but all experience was against its existence, excepting during the suspension of the ordinary laws of nature. The "Carrington-Hodgson" observation of Sept. 1, 1859, was the first to dispel this erroneous impression in the most effectual manner, by exhibiting a burst of yet more vivid flame even in front of the glowing solar photosphere: but this evidence no longer stands alone. Mr. Brodie informs us that he was permitted to witness a second phenomenon of this nature on the morning of last Oct. 2, in the form of a very brilliant body about 4″ or 5″ in diameter, "its light far surpassing in intensity that of the Sun's photosphere," into which it seemed to fall after a course of about 1′ performed in 0·3s. His sketch exhibits a slightly curved tail, which seems to have been identical with its line of flight, but has "two very considerable 'serrations' on its eastern edge." This recurrence of a most interesting, and till recently quite unsuspected phenomenon, ought to put all solar observers especially on their guard, to be prepared to catch and to record these fleeting manifestations of one of the great energies of this wonderful creation.

OPTICAL DECEPTION.

In the Intellectual Observer for October, 1863, an account was given of an atmospheric illusion, by which the telescopic images of the stars were doubled. A similar deception was noticed on Jan. 21 of the present year. Orion, ascending to the meridian in the S.S.E., was found studded with double stars. *Betelgeuse* and *Rigel* were turned into splendid pairs, each having acquired a companion of the 4 or 5 mag., while small stars in like manner were dignified with 10 mag. attendants. ζ presented an especially singular appearance, having a fresh *comes* of about 7 mag., nearly opposite the ordinary one, but at half the distance. These secondary images, which were almost as neatly defined as real discs, were formed vertically above the true star, about 1″·25 or 1″·50 distant from it, upon the first diffraction ring, the light of which, on that side, seemed to be intensified into a bright spot. The appearance was unaffected alike by turning round the object-glass or the eye-piece, or by a change of magnifiers, and evidently resided in the atmosphere. Some 3-mag. stars at a similar altitude in

the S.W. showed no traces of this illusion. *Procyon* in the E. was affected in rather a different way, the light spreading along a broader segment of the ring, and oscillating to and fro. This double refraction was noticed from 8h. to 8h. 30m. p.m., the air being quite still and very favourable for observation, excepting a slight flare in a vertical direction, which latterly became horizontal, pulling out the rays on each side of the discs, and giving them (if so incongruous a metaphor may be permitted) a kind of *grinning* appearance. This passed away in turn, and though there were traces of irregularity in Orion as late as 9h., very beautiful definition succeeded. The circumstances were singularly unlike those of the previously recorded *mirage*, that having occurred on July 27; this in so cold an air that the thermometer marked 19° at 8h. 30m., and 15°·5 at 10h. 30m. The complete calm, however, rendered it very bearable, and the quality of the definition may be estimated from the fact that I never saw the trapezium in the Great Nebula of Orion so finely, and for the first time (excepting a single glimpse one beautiful night) the 6th star came out occasionally as a distinct, though excessively minute point. One eye-piece, however, alone out of three was capable of showing it. The 5th star was a steady object. The grandest astronomical discovery of the age has surely been that of the gaseous constitution of this astonishing nebula. On sweeping upon a subsequent occasion (Jan. 28th), with a power of about 30, over the whole sword of Orion, while wondering at the magnificence of the spectacle, I could not but be struck with the similarity of aspect of all the adjacent nebulosities—that round 42 and 45 to the N., and that encompassing ι to the S., as well as the great nebula between them. Secchi sees them all connected, as parts of one extended mass, whose outlying portions are still more widely spread; and in all probability the whole of this luminous cloud, traceable, according to the Roman astronomer, through more than 5° in a vertical, and 4° in a horizontal direction, may be fairly presumed to be of the same extraordinary composition. The idea of incandescent gas, lying possibly in advance of, rather than beyond, the stars with which it happens to be optically connected, is certainly less magnificent than that of a complication of stellar galaxies of incomprehensible remoteness; but what it has lost in sublimity it may be almost said to have gained in mystery.

DOUBLE STARS.

A little ranging about among the glories of *Orion* has brought forward some pairs which, though small, will repay the search. The first is

127. 84 P.V. This is very near ψ^1 *Orionis*, which is

pointed at by the three gems in the Giant's belt, at a distance equal to their full extent, but lying somewhat *n* of the line. ψ^1 itself is worth looking at for the beautiful low-power field with its open pairs in which it is found. Our object, however, lies rather further, *f*, a little *n*. It is Σ 708. 2″·607. 323°·13. 8·2 and 9·8 (of his scale, equal to about 9 and 10½ Sm.). 1831·81. It is pretty, though minute.

Reverting to ψ^1, we shall perceive, in the finder, about ⅔ of a degree *sp* from it, three dim objects in a slightly curved line pointing *s*, a little *p*, the brightest at the *s* end, the faintest in the middle, but nearer *s*. Of these the *n* is

128. 67 P.V., a wide and very unequal, but pleasing pair, orange and blue. The *s* is

129. Σ 700. 4″·523. 5°·27. 8 and 8·2 (= full 9 Sm.). White. 1831·48. Mädler and Secchi's measures combine to show its fixity. Secchi made them equal, 1857·104. I thought them a little unequal, 1865·052.

Two or three degrees to the S.E., nearly *n* of ϵ, the central gem of the belt, but a little *f*, in a situation forming a tolerably isosceles triangle with ϵ and δ, the uppermost gem, a little sweeping will pick up a group of small stars, whose longest axis lies nearly parallel to the equator, from which indeed it is very little removed. This pretty configuration, which is all in the field of a moderate power, bears a slight resemblance to the constellation *Sagitta*. The stars are all white, and not very unequal in size. The two last form a wide pair, our

130. Σ 758. 11″·062. 297°·72. 8·5 and 9 (about 9 and 9½ Sm.). These, however, are much less beautiful than the central object of the group, at 51″ distance, which is

131. Σ 757. 1″·683. 239°·83. 8 and 8·2 (perhaps 8½ and 9 Sm.). Secchi's observations in 1859 were only sufficient to show that there has been no considerable motion in the group during 28 years. Its insulated aspect would seem, however, to bespeak comparative juxtaposition in space.

Our list of Double Stars has contained so preponderating an amount of easy objects that it would be only fair towards such of our readers as possess instruments of considerable power to introduce an occasional test of a higher class. Such an one we are about to insert.

132. *η Orionis*. This beautiful pair, which does not appear in the Bedford Catalogue, was discovered by Dawes, Jan. 15, 1848, who gave its approximate distance and position 1″ and 87°, with mags. 4 and 5. Mr. Knott has favoured me with the following recent measures:—0″·947. 88°·83. (1863·12). It is a serious objection to many of the more difficult pairs as tests, that their orbital motion is continually altering their distance, of which *η Coronæ Borealis* and 36 *Andromedæ*, both now so

much easier than formerly, are remarkable instances; others of them again are not easily found without circles. The fixity and conspicuousness of the present object would render it a far superior criterion, were it not unfortunately situated so far S. that, like the comites of *Antares* and *Sirius*, it becomes rather an atmospheric than an instrumental test. On really steady nights, however, it affords an excellent trial. I have often seen it divided, and occasionally with a good black separation, with 461, and even 212 will sometimes split it. The smaller component has a ruddy hue. It is readily made out as a moderately bright star lying *sp* from δ, the uppermost of the three in the belt, about as far off as the belt is long.

PLANETARY NEBULA.

In the INTELLECTUAL OBSERVER for March, 1864, p. 139, mention is made of my having missed an extremely faint planetary nebula among the northern stars of the fine cluster 46 M (*Argûs*). A remark by Mr. Knott (to whose kind assistance the present paper owes much of its details) induced me to examine it more carefully, when I found it in a low-power field (65) with so little difficulty that I can only suppose that my eye, which seems to fail me in the search for minute objects near much brighter ones, had previously been distracted by the general sparkling of the more brilliant assemblage. Till once seen, however, it could hardly be called obvious with 5½ inches of aperture. I saw it as a feeble and very ill-defined luminous disc, with a star about 10 mag. on its *sf* border, and some sparklings in it as of 13 or 14 mag. stars. H., who, in 1833, calls it "exactly round, of a faint equable light," says it has a very minute star a little N. of its centre, and is not bright in the middle, nor fading away, but a little velvety at the edges. Lassell, who examined it at Malta in 1853 with his noble 24-inch speculum, and speaks of it as "an astonishing and interesting object," says it has a star or stellar nucleus nearly, but not quite, in the centre, with another fainter star rather nearer the centre than the circumference; and that the nebula seems to retreat from the larger star, leaving it on a much darker ground than the external part of the nebula: two or three points or bright spots in the nebula also occasionally catch the eye. It appears rather singular that the star towards the *sf* edge, so readily seen by Mr. Knott and myself, should find no place in the descriptions of either of our two great observers. Possibly it may be variable. Sm. says most appropriately that the impression given by this nebulosity is "that of awful vastness and bewildering distance"; but this is on the supposition of its starry nature. If gaseous, it may

lie even between our eye and the cluster; but its light may prove insufficient to admit of spectrum analysis. Its synonyms are 39 Lyn IV; 464 H (1833); 1565 General Catalogue.

OCCULTATIONS.

March 3rd. δ^3 Tauri, 5 mag., 10h. 16m. to 11h. 2m.—8th. A^3 Cancri, 6 mag., 7h. 16m. to 8h. 36m.

PROGRESS OF INVENTION.

Railway over Mont Cenis.—Notwithstanding all the aids afforded by modern science, the tunnel under Mont Cenis cannot be finished for several years. It has therefore been decided, in the meantime, to carry a line *over* the Alps, following, almost throughout, the route afforded by the pass of Mont Cenis. France and Italy will thus enjoy the benefits of railway communication within a very short period of time. To effect this, however, it will be necessary to overcome engineering difficulties, which, not long since, would have been deemed insurmountable. The line naturally divides itself into two portions—that on the French, and that on the Italian side; and it is not the least interesting feature of the undertaking that the engineers of these two nations have resolved on attaining the very same object by totally different means. On the French side, locomotives will be used, on the Italian, traction by ropes. On the French side steam, on the Italian, water power. With such gradients as must necessarily be found on this line, a sufficient adhesion between the driving-wheels and rails could not possibly be attained by ordinary means: a very ingenious method of producing any required amount of friction has, therefore, been adopted. A species of rail is to be placed between the ordinary rails: against the upper and lower sides of this, rollers, driven by the engines of the locomotive will act. The central rail being caught between these rollers, any amount of compressing force can be obtained, so as to render it impossible for the engines to work without progressive motion being produced, and equally impossible for the train to descend the inclined plane of its own accord, or too rapidly when descent is intended. On the Italian side, the system of traction is altogether different from that ordinarily used when ropes are employed, and it avoids some of the most serious objections to the use of ropes. A strong cable is placed in the middle of the line, and also an endless wire rope, which is very light, and is kept constantly in motion by power obtained from falling water. Within a waggon, constructed for the purpose, is placed a drum which forms the last element of a system of wheels and pinions. One turn of the cable is passed round this drum. The first element of the system of wheels and pinions is capable of being brought into connection with

the constantly moving endless wire rope. If this element is connected with the ascending portion of the wire rope the train ascends: if with the descending portion, it descends, and exactly at the proper speed: if it is connected with neither, the train remains stationary, being prevented from descending by that part of the cable which happens at the time to be around the drum. The velocity with which the wire rope moves is very great; but this velocity is changed into power, by the system of wheels and pinions in the traction waggon; the required fulcrum being supplied by the strong cable.

Novel use of Water Pressure.—Few persons not familiar with mechanics have any idea of the enormous loss of power which occurs when the masses to be moved are large, and the velocity is high. Friction is greatly diminished by lubricating substances, and still more by friction rollers, but, with ponderous machinery the application of the latter is rarely possible. A contrivance calculated to supply the place of friction rollers, and even to surpass them in efficiency, is coming into use in France. Water, to which a sufficient pressure has been imparted by forcing air into the tank in which it is contained, is made to flow out between the axle and the bearings which sustain it—so as actually to keep the axle lifted out of contact with the surfaces on which it rests. A water pressure of ten atmospheres was found sufficient to effect this with a fly-wheel weighing 35,000 kilogrammes. When this wheel is first started, the bearings are merely lubricated in the ordinary way: but the water is turned on immediately, which causes a very great increase in the velocity of rotation, without any change in the amount of moving power. In experiments which were made to ascertain the efficiency of the principle, it was found that, with merely well greased bearings, the co-efficient of friction was ten per cent., but that, when the water pressure was used, it fell to 0·001, and was never more than 0·003. This arrangement is well suited to the bearing of screw propellers, etc., where heavy weights are to be moved at high velocities; and to test its efficiency, the French Government has ordered it to be applied to the propeller of the screw steam-tug, "Elorn."

Use of Non-insulated Wire for Electro-Magnetism.—A communication made by M. de Moncel to the French Academy of Sciences, at its sitting on the 6th of January, has excited considerable interest, and caused a large amount of controversy. He announced that, in verifying some experiments of M. Carlier, with regard to the use of non-insulated wire, which was described in our last number, he not only ascertained the correctness of M. Carlier's assertions, but arrived at results that filled him with astonishment. He found that not only are helices made of non-insulated wire capable of producing all the results attainable with those in which insulated wire is employed, but that the power is often doubled. He ascertained that, to effect this, it is only necessary to separate the different layers of coils with paper, and, if the bobbin is of metal, to insulate it. He considered the increased power, obtained in this way, as due to the derivative currents which pass across the coils at the points of contact,

and which, though they weaken the current travelling along the wire, augment the total effect by producing an extra excitement of the battery, so that far more is gained in one way than is lost in the other. He ascertained, however, from subsequent experiments, that advantage is on the side of non-insulated wire only when the battery is calculated to produce, or is arranged for, *quantity*—which greatly limits the advantages that such an arrangement may possess. Among these is the partial or total absence of an extra current. Still more recent researches have led him to discover that a large amount of the supposed superiority of the non-insulated wire was due to an accidental superiority as to conducting power, which it happened to possess over the insulated wire that was used in the comparative experiments. Making, however, every allowance for this circumstance, it is still certain that non-insulated wire is best when a quantity-battery is employed. Not only is it cheaper, but it allows a greater number of coils to be put within the same space, which of itself augments the electro-magnetic effect. The use of non-insulated wire for electro-magnetic purposes is not new.

A NEW KIND OF ELECTRIFYING MACHINE.—The electro-magnetic coil has, in a great measure, superseded the electrifying machine: the latter, however, will never cease to be an object of interest; and, it is probable, will always be preferred for some purposes. The expense and difficulty of managing large plates and cylinders of glass have hitherto been obstacles to the use of large electrifying machines. These obstacles appear now removed—glass being rendered unnecessary by the discovery of a far more convenient and effective material. M. Edmond Bequerel exhibited to the Academy of Sciences on a recent occasion an electrifying machine, the plate of which was made of indurated red sulphur, the invention of a civil engineer. It was eighty centimetres in diameter, and afforded a spark fourteen centimetres in length. No amalgamated cushions were required with it, the skin of a cat being quite sufficient to produce every desired effect. Sulphur undergoes extraordinary changes by successive fusions; becoming extremely hard and tenacious. After the third fusion it no longer acts on metals, or possesses its characteristic odour. The plate used by M. Bequerel was formed by fusing the sulphur three times in a cast-iron vessel, at a temperature between 250° and 300° Cent., and allowing it, after each fusion, to cool thoroughly. After the first and second fusions it was crushed to a coarse powder; and, after the third, it was poured into a plaster mould. Plates four metres in diameter may easily be made in this way; they cost extremely little; and, besides being more efficient, are far less hygrometric than glass.

NEW METHOD OF COPYING CRYSTALS.—To produce very beautiful copies of crystals, M. Kuhlmann coats a thin plate of copper with sulphate of magnesia or of zinc, thickened with gum; then lays the copper-plate against another, with the coated surface between, and passes both plates between powerful rollers. The second plate may be employed at once in printing, or it may be reproduced by the electrotype. Instead of a copper-plate he sometimes employs glass, taking impressions of the crystals in gutta-percha, and reproducing

the designs, as before, by the electrotype. As no two crystallizations are exactly alike, and they cannot possibly be copied by the engraver, nor by the photographer, if coloured ink is used, it is considered that printing them from the electro-plates on bank-notes would afford a great additional protection against forgery.

Improved Thermo-Electric Pile.—Up to this time, bismuth and an alloy of antimony have been considered the very best elements for thermo-electric piles. Professor R. Bunsen has, however, recently found that pyrolusite may be employed with far better effect than bismuth, and copper pyrites, with far better than pyrolusite. The pyrites must be used in the natural state, since fusion reduces its power below that of bismuth; but it is easy to form it into a plate of the required size. It was found that a pair consisting of a plate of copper pyrites seventy milimetres long, forty broad, and seven thick, with two copper pins, platinum plated, inserted into it at a distance of thirty-five milimetres from each other, the upper pin having a projection which was heated by a non-luminous lamp flame, while the lower edge of the plate was placed in water, afforded a ten times greater effect than a pair consisting of antimony and bismuth; and a combination consisting of ten such pairs produced all the effects of a Daniel battery, having a copper surface of fourteen square centimetres. During these experiments, the pyrites was heated above the melting point of tin without undergoing any change. Copper pyrites and platinum affords also an excellent pile.

Metallic Coating, so as to Produce a White Surface.—This is effected in a very simple way, by M. Weil. He makes an alkaline solution of the metal which he intends to deposit, and adds to it tartaric acid, glycerine, or some other organic matter. Iron, steel, etc., may with such a fluid be coated with copper, zinc, nickel, etc., and beautiful bright surfaces be obtained. It is usually sufficient to place the object to be coated in the alkaline solution; but, if required, a weak galvanic current may be generated, by bringing it into contact with a piece of zinc.

Lucifer Matches.—There are many reasons which make it highly desirable that phosphorus should be rendered unnecessary in the manufacture of matches. Phosphorus produces one of the most terrible diseases of the jaw in those who manufacture it. No doubt this would not occur were amorphous phosphorus employed; but the latter is dearer, and how few are there so philanthropic as to pay more than is absolutely necessary for anything they require. Also phosphorus, especially the ordinary kind, is highly combustible. How many buildings have been burned, how many lives lost through the careless treatment of lucifer matches! Lastly, phosphorus is one of the essential elements of plants and animals, though it is found in comparatively but small quantities. It is highly mischievous, therefore, to place vast quantities of it in circumstances in which it is scarcely possible for it again to return to the soil, where it is so much needed. Two German chemists seem to have made good lucifer matches, containing no phosphorus. One of them, Dr. H. Poltzer, uses for the match heads a mixture of

chlorate of potash, and, as he believes, a compound of hyposulphurous acid with soda, ammonia, oxide, and suboxide of copper. He obtains this compound by dividing a solution of copper into two equal parts, supersaturating one with ammonia, and the other with hyposulphite of soda; then mixing the two solutions, and stirring briskly. One part of the violet coloured powder which precipitates is mixed with two parts of the chlorate of potash, a little powdered glass being added. This composition detonates by percussion, and ignites when rubbed in a mortar. It is not soluble in water, nor is it hydroscopic; but even when made with moist chlorate of potash and solution of gum its cohesion is so imperfect, that it often crumbles off the matches when they are rubbed. It is also liable to the objection of requiring no particular kind of surface for ignition, which involves the danger of causing conflagrations. Dr. Hierpe uses for the match heads four to six parts chlorate of potash, two parts bichromate of potash, two parts ferric oxide, and three parts strong glue. The ferric oxide may be replaced by oxide of lead, or of manganese. Matches made with this composition will ignite only on a surface coated with a mixture containing twenty parts sulphide of antimony, two to four parts bichromate of potash, four to six parts oxide of iron, lead, or manganese, two parts glass powder, and two to three parts strong glue or gum.

Gas Engines.—It is one of the advantages of modern progress that many operations formerly performed by the painful efforts of man and animals, are now effected with much greater ease and economy by means of power obtained from other sources. A striking illustration of this is found in the use of portable steam-engines in public works. Perhaps a still more striking is the utilization of the enormous water power available in Paris for the lifting of heavy weights to great heights, and in the employment of Lenoir's gas engine for a similar purpose. It is evident that for intermittent efforts the steam-engine is far from economical, on account of the necessity of keeping up the steam during the intervals of inaction. This objection does not hold with the gas engine. It consumes nothing when it is not actually at work, it is, besides, very portable, and the gas, as also the water for refrigeration, it requires may be had almost anywhere. It is not surprising, therefore, that it is coming into use in France in building operations, any defects it may possess being more than counterbalanced by the advantages it offers.

The Electric Light Adapted to Use in Mines.—Notwithstanding the excellence of Davy's lamp, especially in its improved forms, the most lamentable accidents are of constant recurrence in mines; sometimes, no doubt, they are due to imperfection in the lamp, but most usually to imprudence in the miners. The use of electricity, as a means of illumination, would remove all danger of this kind; but hitherto its light, though very intense, was useless for ordinary purposes on account of the impossibility of rendering it sufficiently diffused; and, besides, its arrangements were complicated, on account of charcoal points being necessary. These objections seem

to have been overcome by a lamp maker of Paris. Instead of charcoal points he employs an apparatus of glass, within which the air is greatly rarified, so as to allow a passage to the electricity, and afford a mild light, something like that of an aurora borealis, but quite sufficient for the miner. As this lamp produces no heat whatever, it is impossible for it in any circumstances to ignite an explosive mixture of gases. The galvanic battery it requires is enclosed in a small box, which is carried on the back of the miner, or is placed in any convenient situation near him.

Mr. Stewart Harrison's Self-Acting Preserver Valve, for the Preservation of Life and Property from Fire.—This valve is part of a system designed by the inventor to prevent the occurrence of fires, in the official sense of that word, by extinguishing them at their commencement. He proposes that in warehouses, at the docks, in public buildings, libraries, etc., wrought-iron pipes connected either with a tank on the top of the building, or with the fire mains in the street, shall be put up on the ceiling of each floor, so as to divide the surface to be protected into spaces, greater or less, according to the combustibility of the goods. To these pipes the preserver valve is to be attached. The valve, which is globular in form and perforated with numerous holes, is kept closed by a screw passing through a stirrup of brass, whose ends rest on two small pins of fusible metal, which melts at 212 degrees Fahr. Upon a fire breaking out, the heat ascending to the ceiling, and melting one of the pins belonging to the nearest valve, the water is poured down on the precise spot at which the fire is commencing. Should the heat be sufficient, it will melt several of the pins immediately surrounding the central point, and the water falling on the goods below will prevent the spread of the fire to them. In this way, it is believed by the inventor that it would be impossible, with a proper supply of water, for the damage under any circumstances to be very great. For libraries, dwellings, etc., the valve can be concealed beneath ornaments on the ceiling, without any disfigurement to the rooms in which it is fixed. For ships and steam-vessels, where a large tank of water is not possible, the pipes run along the beams, and are connected with a cistern on the highest part of the deck. When the valve opens, the altered level of the water in the cistern causes a float to sound an alarum; on which the ship's fire-engines are connected with the system of pipes, and the water from them is directed exactly on the seat of the fire. The water is not, therefore, as at present, blindly thrown wherever the smoke may appear (however falsely) to indicate the part on fire, injuring the cargo as much as the fire itself. Mr. Stewart Harrison has also designed an alarum, which sounds whenever the water flows through any of the valves, thus giving timely notice to the watchman, porter, or passer-by, that the fire is being put out, and enabling them, on its being extinguished, to prevent further damage by turning the water off from that set of pipes. The valve and alarum, we believe, can both be seen in action at the inventor's, No. 133, Upper Thames Street, E.C.

Miscellaneous.—The *lime light* has been applied to the produc-

tion of enlarged images of opaque objects, such as photographs, for the use of portrait painters, etc. It is reflected from a large concave mirror through a nine-inch condensing lens; and passing thence to the object, which is placed at an angle of 45°, it is reflected to a double acromatic object-glass, which refracts it so as to form a picture on the screen intended to receive it.——*Aluminium bronze*, consisting of ninety parts copper and ten aluminium, is used with very great advantage as a casing for bearings which, when ordinary materials are used, are liable to become heated, on account of the high velocities of the moving parts. It was found to answer admirably for a mandril, which made 7000 revolutions in a minute, and with which, every other bearing tried, had proved a failure.——*Electro magnetism* has been applied by Sir Charles Fox to the overcoming of one of the greatest difficulties connected with railways, namely, the want of sufficient adhesion between the driving-wheels and the rails. For this purpose, deflected belts of insulated wire are placed round the lower portions of the driving-wheels of the locomotive, which, when these belts are connected with a galvanic battery, become powerful electro-magnets that attract, and are attracted by, the rails. As the wheels revolve within the belts, their lower portions, for the time being, are always magnetic. The belts are supported by slings, and steadied by stays, and are capable of being connected together, etc.——It is supposed that the sudden and spontaneous extinction of burning *magnesium wire* arises from the presence of particles of oxide. Magnesium possesses no ductility; and hence, to form it into wire, it is forced in a fluid state through holes in a steel die. This causes portions to be oxidized, as the metal is highly oxidizable in the fluid state, and the particles of oxide are incorporated with the wire. All inconvenience from this oxide is prevented by adding to the magnesium lamp a spirit lamp, through the flame of which the magnesium wire is transmitted at a proper speed, by means of suitable mechanism.——It has been proposed to propel omnibuses, etc., through Paris by means of a motive power, which is to be derived from *gaseous ammonia*. It has been calculated that if twenty kilogrammes of liquefied ammonia are vaporized, and the vapours are received in sixty kilogrammes of water, a power equivalent to that of two horses for one hour, and sufficient to propel an omnibus through Paris, will be obtained. This use of ammonia is believed, by the projectors, to be feasible, because, first, gaseous ammonia may easily be liquefied; secondly, its vapour affords at ordinary temperatures a pressure that is utilizable, and it may be superheated without recourse being had to a high temperature; and, lastly, the latent heat may be recovered from the utilized vapour, and communicated to the vapour which is about to be produced, by a mere solution of the gas in water. It is proposed to manufacture liquid ammonia in large quantities in a central establishment, from which it will be distributed, as required, to the various omnibuses, etc.; and to bring to the same establishment the water in which the ammoniacal vapour will have been condensed, that the ammonia may be recovered from it.

LITERARY NOTICES.

HARMONIOUS MAXIMS OF SCIENCE AND RELIGION. By the REV. WILLIAM BAKER, M.A., Vicar of Crambe, near York (Longmans).—The author of this work contends that the reconciliation of science with theology must be effected by tracing out in both departments a series of truths, which only became cognizable through accurate study, and which often contradict those interpretations of natural or revealed phenomena that are accepted by the unlearned. We can only mention the scope of this book, without offering any opinion on its merits or defects.

PHILOSOPHY OF RELIGION. By HUGH DOGHERTY, M.D. (Trübner and Co.)—This is a short pamphlet of controversial divinity, a subject with which we do not meddle. Those parts which touch general philosophy appear to us to want precision and distinctness. Dr. Dogherty is too fond of long-tailed words and learned-looking expressions. We certainly do not feel disposed to attack his "epicosmology" with its "sacred numbers in individual organisms; discrete organisms in the indivisible unity of human nature," its "one primary and three secondary classes in its realm in epicosmic nature;" or its "three degrees—individual, realmic, and epicosmic." A wise man will always distrust thoughts that cannot be expressed in simpler terms.

INVENTIVE DRAWING: A New Practical Development of Elementary Design. By EDWARD BALL. (Hardwicke.)—This is an admirable work. Mr. Ball's notion of teaching drawing is both practical and philosophical. All objects in nature, and beautiful productions in art, may be analysed into simple elements. The most elementary forms will be combinations of rectilineal angles, or angles formed by straight lines. Mr. Ball shows how, from the simple meeting of two straight lines, the pupil may proceed to pleasing pictures formed by combinations of straight lines; and he likewise illustrates the approximate mode in which they can be made to represent animal forms grotesquely caricatured. Part II. relates to the combinations of triangles, in which the progress of rectilineal design is carried further than in Part I., and we arrive at patterns of considerable elegance, entirely formed of a multiplicity of triangles of various sizes, and in which the effect of shading is produced by making nests of triangles, one inside the other, repeated five or six times. In Part III. four-sided figures assist the triangles in building up fresh devices, and in Part IV. simple curvilinear figures are introduced, and excellently applied. Part V. is devoted to geometric figures, bounded by right lines; and the subject is continued in Part VI., in which curves and right lines are combined. Part VII. is devoted to "designs from nature, illustrating the use of the elementary and compound forms in diapers;" and Part VIII. shows how simple, but effective patterns for windows may be composed. The merit of this work consists in the execution as well as in the idea. It will lead the student on pleasantly and

quickly, first, to see in the objects around him the artistic elements of which they are composed, and, secondly, to perceive how these may be combined so as to produce an endless variety of effects. The book offers suggestions that will be valuable to practised adults, but its well-arranged steps and excellent illustrations will soon conduct any tolerably clever child to a substantial, though rudimentary knowledge of drawing and of decorative art. The book will be a favourite in every family in which it is introduced, and it will be found that most children begin to attend to form at a much earlier age than is commonly supposed. We remember a clergyman at Huntingdon who managed some schools for his poor parishioners with great skill, and he found that little creatures, four or five years old, took great delight in tracing the outlines of forest leaves on a scrap of paper. In many cases this was the foundation of considerable proficiency in subsequent life.

Two Months in a London Hospital; its Inner Life and Scenes: A Personal Narrative. By Arnold J. Cooley, Author of "Cyclopædia of Receipts, Processes, Dates, and Collateral Information," "Dictionary of the English Language," "Latin Grammar," etc., etc. (Groombridge and Sons.)—A severe and dangerous accident unfortunately made Mr. Cooley the inmate of a London hospital, and he improved the melancholy occasion by watching all that occurred within his sphere of observation, his own sensations included, and compounding his experience into a very readable book. The details of hospital life are well described, and many pathetic and startling incidents graphically pourtrayed. Mr. Cooley suffered with an attack of erysipelas, which made him delirious, and he has recorded the strange fancies that arose in his disordered mind, and the various scenes in which he imagined himself to be an actor or spectator. These chapters will interest many readers, and they are not without scientific psychological value. He remarks, with reference to this part of his experience, that "the quiet delirium of erysipelas—that variety which has chiefly to do with my narrative—is more closely related to dreaming than the others. Indeed, whether occurring by night or by day, it clearly resembles a continuous day-dream of a varied and very vivid character, occurring with the senses, or some of them, more awake than in what is popularly called 'day-dreaming,' by which the sequence of ideas or illusions, though irregular, are usually more connected, persistent, and continuous than in ordinary dreams. In general, as in dreaming, the illusions and irregular trains of thought primarily depend on the suggestions of immediate influences. Among these, sounds heard and misunderstood by the patient are the most prolific. His pains and sensations also act in the same way. The subject, the thoughts floating through his mind as he passes into a delirious state, likewise frequently furnish the groundwork on which his subsequent wanderings are raised. Then imagination begins her work, and memory supplies her stores to continue and diversify the vision or illusion. And, lastly, the usual habits or bias of the mind in health give a tone to the whole, and leave the thoughts rambling on a train of favourite subjects, until the patient is

aroused, or until he sinks into a state of actual sleep or stupor from exhaustion."

NOTES UPON THE ERRORS OF GEOLOGY: Illustrated by Reference to Facts observed in Ireland. By JOHN KELLY, Vice-President of the Royal Geological Society of Ireland. (Longmans.)—Mr. Kelly is acquainted with a considerable number of geological facts, and he puts them to a very curious and singular use. He thinks men like Lyell, Murchison, Phillips, and Ramsay all wrong. They can only account for the appearances they observe upon the supposition that the causes producing them were in action during very long periods, while Mr. Kelly requires all sedimentary rocks to be made in a hurry. He supposes that a few thousand years ago there was a turmoil in the interior of the earth, and "its hard nucleus of granite was split up into large blocks by volcanic agitation." "Suppose," he says, "one of these blocks heaved up by the expansive power of steam, and, on the escape of the steam, let down again by its own gravity. In the fissures or joints about the block, after having been put in motion, there would have been a considerable amount of ground granite made by the sliding or friction of the moving block." Notwithstanding that this process is supposed to have taken place at the bottom of the sea, the "granite would be," in Mr. Kelly's hypothetical arrangements, "red-hot, or nearly so." Having obtained a large quantity of powdered granite, nothing is easier than to make it into strata, sorted out according to the size of the particles. It only requires "another volcanic heave and a puff from below" to scatter all the materials about in the water, and allow them to subside into any quantity of sedimentary rock that might be required. The operation commences with the formation of great cracks in the sea bottom. "Call every such fissure a Grinding Machine. In this way give it steam power to lift the block, gravitation to cause it to slide down, friction to grind off projections in the act of sliding, and make sandy depressions to receive this sand; and steam again to blow out the ground stuff, a vacuum left in its place, cold water to rush into the vacuum, hot granite to convert that into steam again, for a new effort." Ten or twenty thousand of such grinding machines all going at once in a hundred square miles of ocean bottom, would, according to Mr. Kelly's computation, make a bed over the whole area twenty miles thick in a century, or, working at half speed, they would turn out "any of our geological systems" in that time. We ought to add that Mr. Kelly knows of actions of this sort in Ireland, we presume in some parts, verifying the old joke, that the laws of nature refuse to operate in that interesting country.

ARCHÆOLOGIA.

THE season is very far from favourable to any new archæological discoveries, and we are obliged to fall back upon some of the later explorations of the past autumn, which are still occupying the attention of antiquaries. Among these may be specified the less recent discovery of the foundations and floors of BUILDINGS IN CHESTER, the *Deva* of the Romans, under whom it was the station of the twentieth legion. Two lectures on local antiquities have recently been delivered at Chester by Dr. Brushfield, a prominent feature in the second of which was a searching inquiry into the grounds upon which Mr. Tite founded his opinion, that a building laid open during the last year in the heart of the town was a Roman temple. Mr. Tite had published his reasons in a paper read before the Society of Antiquaries, and Mr. Scarth, in his "Roman Bath," has drawn attention to its analogy to a temple discovered years ago in that city. Dr. Brushfield disputes the correctness both of Mr. Tite's conclusions and of his facts, and the close attention he and his coadjutors gave daily to the remains during the discovery adds weight to his views. The lectures, with illustrations, are about to be published by the Chester Archæological Society.

We have already described the EXCAVATIONS AT BRADWELL juxta Mare, which appear to have brought to light at last the remains of the lost Roman military station of Othona, the Ythancester of Bede. These researches are, we believe, still continued as the weather permits. Some antiquaries had already conjectured that it stood somewhere near this locality; but what caused others to pause before deciding was not only the fact that no vestiges were to be seen here, but the conflicting fact, as it seemed, that at Felixstowe, on the Suffolk coast, the sea had overthrown a Roman castrum, parts of the walls of which are still to be seen at low water. At one place, therefore, remains existed without historical evidence or any affinity in names; at the other, the site on the river Pant is pointed out by Bede, but no remains were to be seen. The site at Bradwell had, as we have stated in our former notice, a ruined church named St. Peter's-on-the-Wall, apparently of late Norman work, and constructed in part of Roman materials. It was hardly supposed that this church was so termed from standing upon one of the walls of a Roman station, yet this turns out to have been the case. Further investigation will no doubt throw more light on this interesting question.

In these days of universal explorations, it is something noteworthy to bring to light A ROMAN WALLED STATION; but it is probable that, even in our own country, remains of this kind are yet to be found for the trouble of excavating; and this is the case, to a more remarkable degree, in some parts of France. It is only a few years ago, a French antiquary, M. Boilleau, discovered at Larçay, near Tours, a fine and very well-preserved Roman fortress, with its massive walls almost entire. It stands a short distance out of the

road, and no one ever thought of looking for it. Mr. Roach Smith has given some account of this discovery in his "Collectanea," vol. iii. p. 218; and in the same volume, p. 103, he has given a longer and still more interesting account of the extensive remains, at the village of Jublains, in the department of Mayenne, of the ancient chief town of the Diablintes, which, until recently, had been almost as little known. The whole district of Mayenne and Jublains is, indeed, almost unknown ground; and Mr. Roach Smith informs us that, on his visit to Jublains, he found *in the woods* remains of large buildings, the walls of which had been cased with thin slabs of polished marbles of various kinds, and an amphitheatre, not excavated.

We have just received information of an interesting discovery lately made in this last-mentioned district. At a particular part of the river, where there seems to have been a bridge or ford, in the route from Jublains to Avranches, portions of a milestone have been found, and upwards of three thousand coins, many of which are of the flower of the die, having been preserved from the action of the air by the water, precisely like those found in the Thames at London Bridge. Of these coins, three are consular, many of Augustus, seven hundred of Claudius, many of Nero, more than five hundred of Tiberius, others of Caligula, Germanicus, Hadrian, Nerva, Trajan, Vespasian, Titus, and Domitian; some rare colonial coins; five or six of the two Faustinæ. Of the lower empire there appears to be only a few, three of which are of Gallienus, Postumus, and Tetricus. Among other remains found with them are a bronze axe, or, as we understand it, one of those implements our antiquaries are accustomed to call celts. The miliary column alluded to has an inscription, of which only the following letters remain:—

. . .
NIO.V
INVIC
AUG.P.
).IIII

The last line gives, no doubt, the distance from Jublains, the capital town of the Diablintes (about four miles).

We can hardly allude to the progress of archæology in the month of February, without a passing word on the loss of one of the great patrons of this science, who has just been gathered to his fathers. The late Duke of Northumberland was a zealous and enlightened encourager of antiquarian research, especially in that part of England in which his own ancestral estates chiefly lay. He had patronised largely the labours of Dr. Bruce on the antiquities and history of that great monument of the Romans in Britain, the wall of Hadrian; and he had expended large sums of money in an efficient survey not only of the wall, but of the other Roman remains in Northumberland, the result of which was an important work, printed for private distribution, under the title, "The Roman Wall, and Illustrations of the Principal Vestiges of Roman Occupation in the North of England; consisting of Plans of the Military Works, the Stations, Camps, Ancient Ways, etc., from Original

Surveys made by direction of his Grace the Duke of Northumberland, K.G.," by Henry Maclaughlan, folio, 1857. These antiquarian researches were, we believe, continued till near the time of his demise. T. W.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

NATURAL HISTORY SOCIETY OF DUBLIN.—*Jan.* 6.

On Fissiparous Reproduction Observed in Anthea Cereus.—Dr. E. H. Bennett read a most interesting account of an instance of fissiparous generation which he had been enabled to observe accurately. One morning last July he brought from Seapoint three specimens of *Anthea cereus* (the ash-coloured variety), and put them into a large aquarium. They were uninjured, and at once attached themselves to the stonework of the aquarium, expanding their tentacles to the full. He had on previous occasions failed in getting this species to do well in the vessel, from some fault in its management, and consequently watched these with some interest. During the evening of the day on which they were put into the vessel he was surprised to see one of them moving about in a most unusual manner. The species is always rather restless as compared with others, but this individual seemed to be suffering from some extreme excitement, being constantly in rapid movement along the stone-work, and waving its long ash-coloured tentacles in the wildest manner. Late at night the Anthea was on the highest point of the stonework, in the centre of the vessel; in the morning it was attached high up the front glass of the vessel, and was still in the same state of excitement. Its position on the front of the vessel afforded the best possible opportunity for the examination of its structure and movements. He made a most careful examination of it, and assured himself that it was perfectly free from any injury. On his return home, at about three p.m., he at once examined it and found that there was in the centre of the base a small, irregular opening; the base itself was no longer circular, but had extended itself in the vertical direction to the utmost, and formed a long, narrow oblong. So great was its extension lengthwise, that the column of the animal was almost flat on the glass. The opposite ends of the base seemed to be working to the utmost to increase the distance between them, and the tentacles waved about more vigorously than in the morning. It occurred to him that this excitement and muscular exertion in the base was owing to the fact that the animal was attempting to divide spontaneously. He determined to watch the process, and sat down in front of the vessel. In a few moments the opening in the base became wider, more irregular, and was evidently increasing

from the violence of the muscular efforts. Presently the opening in the base extended to the margin, and up the right side of the column, exposing to view the internal structure—the septa and so-called craspeda. At 4·20, twenty minutes after the rent had reached the right margin of the base, it extended to the left, and so divided the whole base into two nearly equal segments. It is a curious fact that the tentacles corresponding to the two parts now contracted separately; hitherto the contractions were convulsive, and set in suddenly at intervals and altogether, now there was a distinct pause between the convulsion of the upper and lower division, the upper always preceding the lower by a few seconds. At 5·10 the walls of the stomach could be seen strained across the fissure, and they presently gave way, the rent extending right through the column to the oral disc. This appears to suggest that the seat of the central nervous system of Actinia occupies the base, as Spix thought he had demonstrated, although this demonstration has been rejected by every authority who has followed him. On one margin of the disc the rent involved the base of one of the outer row of tentacles, and extended along it. He was much interested in watching its progress along the tentacle, as it seemed doubtful whether it would tear along its whole length, or detach one or other half from its attachment to the body. The strain seemed great on the parts, and at last the lower half tore off from its base, and, immediately closing into a perfect tube, hung as a branch from its parent trunk. The wound in this, too, seemed to close at once when the strain was taken off. Dr. Bennett mentioned this apparently trivial detail as it appeared to explain the occasional occurrence of the double or branched tentacle which has been observed in *Anthea cereus*. At 5·45, less than three hours from the commencement of the process, the division was complete, the upper half falling to the bottom of the vessel. At 6·5 the lower followed it, and the two new individuals lay together almost motionless. Next morning one attached itself to the glass, and showed its base nearly perfect; the other lay much in the same place as the evening before. Dr. Bennett was unable to continue his observations on these two animals any further; the water in the vessel became turbid, and many of its inhabitants died, including the two *Antheæ*. They were able to move about for some days, but never with activity. They seemed, however, to have quite closed up their wounds. He could not examine them anatomically, as they were so softened before removed from the vessel that dissection was impossible. The others of the same species which were put into the vessel had also tried to divide, and apparently in the same way, from base upwards. The observation proves that division was completed, and that the two halves lived as independent animals for a few days. The whole time which the division took, from the first observation of the opening in the base to the complete separation of the halves, was barely three hours. The exciting cause of the process seems to have been the condition of the water in the vessel, just verging on decomposition. The most important part of the observation is the mode of the division.

The only case recorded of a similar kind is in Gosse's *Tenby*,

where, speaking of the rarity of the occurrence of fissiparous generation in Actiniaria, he states that he had never seen it occur spontaneously himself, but quotes the following observation of a friend:—"An *Anthea cereus*, which had been in captivity thirteen days, devoured with great relish a dead shellfish. I watched the operation of seizing and swallowing, and there was nothing remarkable in the appearance of the Anthea on Monday. On Tuesday morning, going to look at my prisoner, I observed the rejected shell at the bottom of the jar, and, to my great puzzlement, instead of one Anthea there were two, of nearly equal size, but smaller than my old friend. Both appeared languid, and from the margin of one two tentacua appeared sprouting; they hung in so very flaccid a state that I could not examine the mouth yesterday, but to-day one exposes a mouth fully formed." We have little else recorded here than the fact of the division and its extreme rapidity. There can be little doubt that in this case, as in Dr. Bennett's, the division was effected by muscular action. Nearly a century ago Decquemare observed that several Actiniæ could be divided artificially in almost any way, the several parts being capable of forming independent animals. Sir J. Dalyell has recorded a mode of reproduction in one species—*Actiniæ lacerata*—accomplished, apparently, by muscular action. He describes, in this species, the outline of the base becoming sinuous, and the prominences gradually, in the course of a week or two, becoming pinched off, maintaining their connection only by a very slender lengthened filament, not in contact with the glass, but free above it. Rupture of the connecting thread at length takes place, and the independent fragment becomes developed into a perfect anemone. He says of the process:—"It is not quite obvious how the prolongation is effected, unless by contraction of the basis and recession." All authorities agree in stating that fissiparous generation occurs either in the way described by Dalyell—by separation of a part of the margin of the base, or by division from above downwards, not from below upwards, as I have described. Milne Edwards says:—"Spontaneous fissiparous generation occurs either by detachment of fragments from the inferior border of the body, which, continuing to live, become developed into perfect animals, or at other times division commences by a narrowing or strangulation (*etranglement*) of the superior extremity of the body, which, becoming more and more pronounced, causes a bifurcation, the branches of which complete themselves each on its own side, so as to constitute two distinct individuals. These may remain united by the base, and so cause an aggregation of polypes, or may be separated completely." Dalyell is the only authority who attributes the separation of the fragments, in any case, to muscular action. How the process is effected when it occurs in the more common way—from above downwards—is difficult to imagine, unless it be similar to ulceration in higher animals, or due to muscular action. Gosse evidently attributes it to a process of growth. He says:—"The greater part of the Astræacea increase by disc buds and spontaneous subdivision, the disc of the polype gradually widening by growth,

and finally separating into two portions, which become independent." Whatever be the means by which the separation is accomplished, in the greater number of cases it was evident that, as in the exceptional case recorded, the animal absolutely tore itself into halves; and further, that the division occurred in a direction from below upwards, the reverse of that which is supposed by some to be the constant mode in the class.

PHILOSOPHICAL SOCIETY OF MANCHESTER.—*Jan.* 24.

On the Physiological Effects of Carbonic Acid.—Dr. Angus Smith related the results obtained by some very valuable experiments on breathing in close chambers. Dr. Smith had an air-tight leaden chamber constructed, containing 170 cubic feet of air. On remaining in this chamber until the carbonic acid produced by his breathing, and the burning of candles amounted to 3·9 per cent. of the enclosed atmosphere, he found that his pulse fell so low that he was scarcely able to count the beats, which diminished rapidly in number. As this effect was speedily produced, and as there was no time for the accumulation in the air of any large amount of organic matter, the effect must have been chiefly due to the carbonic acid. The experiments were frequently repeated, each time with the same results, the number of beats of the pulse diminishing as the carbonic acid increased in quantity, and the breathing quickening in the same ratio. The lowest amount of carbonic acid producing these unfavourable results was found to be 0·1 per cent., an amount often greatly exceeded in private houses and public meetings, where it often rises to 0·2 or even 0·3 per cent. As a proof that the long-continued action of an atmosphere charged with an undue quantity of carbonic produces permanently injurious results, Dr. Smith quoted the cases of the Cornish miners, who are remarkable for the peculiarity of a feeble pulse. In Dr. Smith's experiments the pulse and the breathing returned to the normal state after a few minutes' exposure to fresh air, the rapid, gasping, or panting effect produced by the carbonic acid quickly passing away.

ROYAL INSTITUTION.—*Feb.* 3.

Mode of determining the Atomic Weight of an Element.—Professor Odling's discourse on some new compounds of the metal aluminium, although of especial interest to the chemist, offered a good opportunity to every one moderately conversant with science, of becoming acquainted with a most important chemical doctrine. The question which has been agitating the chemical world during the last few years is this:—"How can we tell the true atomic weight of an element?" In other words, "What is the smallest proportion of any element, taking hydrogen as the unit, which can enter into a chemical compound?" In the annexed abstract of Dr. Odling's remarks, an answer to this question, so far

as it relates to the element aluminium, is given. The subject was introduced by a few words relating to the more ordinary aspects under which this element is generally regarded.

Of all the elements, aluminium is the third in order of abundance; among the metals themselves it is the most abundant. Yet it seems not to be a necessary constituent of the animal or vegetable kingdoms; in the mineral kingdom, however, it is widely distributed, and occurs in immense quantity in rocks, and clays, and gems. It has been turned to many useful purposes in the arts, as in the manufacture of pottery and porcelain, and in mordanting fabrics. In spite of the abundance and the universal distribution of aluminium, and notwithstanding its importance in the arts, the chemical constitution of its compounds has received less attention than has been accorded to the compounds of some of the rarer metals.

The evidence as to the constitution of compounds, and the atomic weight of elements is twofold:—

a. Specific Heat.
b. Vapour Density.

a. Specific Heat. We know that equal weights of different elementary metals, heated to the boiling point of water, melt different quantities of ice; *e. g.*, 1 part by weight of silver melts twice as much ice as 1 part by weight of bismuth—the specific heat of silver is, therefore, twice that of bismuth. But, on the other hand, it is found that the atomic weights of these two metals, taken, say in *decagrammes*, melt the same quantity of ice; therefore we conclude that atomic weights of silver and bismuth have the same specific heat. Extending this experiment to other elements, we find that the weights capable of giving equal "melting power" will be for certain metals:—

Lithium	Li	= 7	Tin	Sn	= 118
Magnesium . . .	Mg	= 24	Mercury	Hg	= 200
Zinc	Zn	= 65	Lead	Pb	= 207
Arsenic	As	= 75	Bismuth	Bi	= 210
Silver	Ag	= 108			

The foregoing numbers are, then, the atomic weights of the above-named elements.

Now the amount of aluminium having equal melting power to 108 of silver is 27·5, not 9·2, nor 18·3, nor 36·7. The chloride is, therefore, not $Al' Cl$, nor $Al'' Cl_2$, nor $Al'''' Cl_4$, but $Al''' Cl_3$.

b. Vapour Density. The atomic weight of a metal will be the quantity contained in two vols. of the gaseous chloride. Thus two litres of hydrochloric acid, H Cl = 1 *crith** of hydrogen, H, + 35·5 criths of chlorine, Cl: the atomic weight then of H = 1. And so

* *Crith.* The term crith has been lately introduced into chemical language. A crith of hydrogen is the weight of one litre of that gas at the standard temperature and barometric pressure. One litre of chlorine contains consequently 35·5 criths, 35·5 being the atomic weight of that element, and so on with other gases.

with other elements. With regard to aluminium, Deville has shown that two litres of gaseous chloride of aluminium = 55 criths of Al + 6 times 35·5 criths of Cl:—the atomic weight then of Al = 55, and the formula of the chloride is consequently Al$''''''$ Cl_6, or $Al_2 Cl_6$.

Which determination of the atomic weight is right? Specific heat says one thing, vapour density another. But take the vapour density of another aluminium compared. Dr. Odling finds that two litres of aluminium methide, or ethide vapour, contain only 27·5 criths of aluminium; Al$'''$ Cl_3 is, therefore, the right formula for the chloride and the atomic weight of Al = 27·5. This determination of the atomic weight by the vapour density of the new bodies thus confirms the results deduced from the specific heat of the metal itself. The vapour density of the chloride is not an adequate guide, being, as is the case with some other chlorides, anomalous.

In the concluding part of his discourse Dr. Odling illustrated the properties of the new substances made by Mr. Buckton and himself; namely, the aluminium methide, a compound of the organic radicle methyle ($C H_3$*) with aluminium, thus—$Al Me_3$ †; and aluminium ethide $Al Et_3$; Et representing ethyle, $C_2 H_5$. These bodies occur, according to the temperature, either in crystals or in the liquid, or in the gaseous form: they are spontaneously inflammable, and explode under water. They are made by digesting the mercury compounds of methyle and ethyle respectively, with aluminium clippings.

NOTES AND MEMORANDA.

Meteor observed at Sea.—The following communication has been received from Joseph D. Dickinson, Esq., late 4th Regiment, and was written by him on the voyage to New Zealand, a few days before landing:—"On board ship 'British Trident,' October 23rd, 1864. We were yesterday in lat. 46° 49′ south, and long. 124° 12′ east, when, at about ten o'clock p.m., our attention was drawn to a very brilliant streak of pale light, extending right across the heavens from east to west. The side of the streak next to the south was well defined, that next the north not so well. In breadth it was about 7°, but narrowed a little, and was less brilliant towards the extremities. When I first caught sight of part of it, between two sails, I thought it was the tail of a comet, which, indeed, it much resembled; but when I saw more of it I knew I was wrong. There was at the same time a clear pale light in the south, from which I could, for a short time, distinguish a very faint ray extending upwards. This part of the heavens was, however, soon obscured by a thick bank of clouds, which rose up so as effectually to prevent our seeing anything more in that direction. The streak overhead lasted (sometimes fading a little, and then getting bright again) until quarter-past eleven p.m., when it appeared to break up into a number of streaks like tails of comets, extending from the southern side of the original streak in an E.N.E. direction, the wind at the time being W.N.W. These remained very bright for a few minutes, and then faded away. During the whole time there were no clouds to be seen, except the

* C = 12. † Al = 27·5.

bank in the south. I supposed the appearance above described to have been the Aurora Australis; but the captain and officers of the ship, as well as those passengers who have been living in the southern hemisphere, all said that they had never seen anything like it before, and that all the auroras which they had seen showed bright lights of many different colours, constantly shifting, but never this steady pale light.—[It must have been an exhibition of the aurora: the colours often seen are not essential to the phenomenon].—Mr. Alexander S. Herschel, to whom the above description was shown, has kindly sent the following account of a somewhat similar appearance, described by Dr. J. D. Hooker, *Himalayan Journals*, large 8vo edition, vol. ii. p. 385:—"1848, Feb. 14, nine p.m. Baroon (east bank of the Soane River, lat. 24° 52′ N., long. 84° 22′ E., alt. 345 feet, bar. corr. 29·751, temp. 62°, dew point 41°0. Calm, sky clear, moon ¼ full, and so bright that the milky-way and zodiacal light could not be discerned, and the stars and planets were very pale). Observed about thirty lancet beams rising in the north-west, from a low luminous arch, whose extremes bore W. 20° S., and N. 50° E.; altitude of upper limb of arch, 20°; of the lower, 8°. The beams crossed the zenith, and converged towards S. 15° E. The extremity of the largest was forked, and extended to 25° above the horizon in the S.E. by S. quarter. The extremity of the centre one bore S. 50° E., and was 45° above the horizon. The western beams approached nearest the southern horizon. All the beams moved and flashed slowly, occasionally splitting and forking, fading and brightening. They were brightly defined. At ten p.m. the luminous appearance was more diffused. No beam crossed the zenith, but occasionally beams appeared there and faded away. Between ten and eleven the beams disappeared from the S.E. quarter, and the longest and broadest beams were near the N. and N.E. horizon. Those who were witnesses of the appearance considered it a brilliant display of the aurora." Mr. Herschel observes that in this case the beams ruled the sky from N.N.W. to S.S.E., and nearly from horizon to horizon: *i.e.* nearly north and south, and nearly horizontal, which is an uncommon appearance.

Temperature and Development.—M. Dareste has communicated to the French Academy the results of experiments on the development of embryos in fowls' eggs, at comparatively low temperatures. He finds that the germ does not become an embryo below 30° C. or 86° F. Embryos formed between 30° and 34° C. grow very slowly, and none are hatched. Many of the embryos became monstrous, some presenting anomalies in the head, others were like cyclops, and these often exhibited two rudimentary hearts.

Stool for Astronomers and Artists.—In using telescopes of three or four inches aperture, mounted at 5½ or 6 feet from the ground, a great many objects are conveniently seen when the observer is seated on a firm stool capable of adjustment, varying its height from 19 to 31 inches. For this purpose, Mr. Slack has had a stool constructed of oak, well dovetailed together. It consists of two parts. The outer part, 18½ inches high and 11 by 13 wide, is like an oblong box, open at top and bottom. Into this slides a similar box, closed at the top by a seat slightly overhanging the sides, and half an inch thick. On opposite sides of the outer part are cut two slits three-eighths of an inch deep, and three inches wide. These slits are two and a half inches below the top, and exactly correspond with each other. On opposite sides of the inner parts there are two sets of slits of the same dimensions. Each set contains thirteen slits, and when the inner part is dropped down as far as it will go, a bar of oak three-eighths of an inch thick, and three inches wide, passes from side to side through the two outer slits, and through the top slits of the inner sets. From centre to centre, the inner slits are one inch apart, and when the stand has to be raised, the slide is pulled out and pushed in again through the slits, which correspond with the elevation required. A little practice enables this to be done in a moment, even in the dark, and the stool is quite firm at its greatest elevation. A stool of this kind must be thoroughly well made, or it would be a ricketty, troublesome affair. The one described, made by a first-rate workman, cost 35*s.*, and has been in use for several months, leaving nothing to be desired. It is evident that a stool of the same description would often be very convenient for artists.

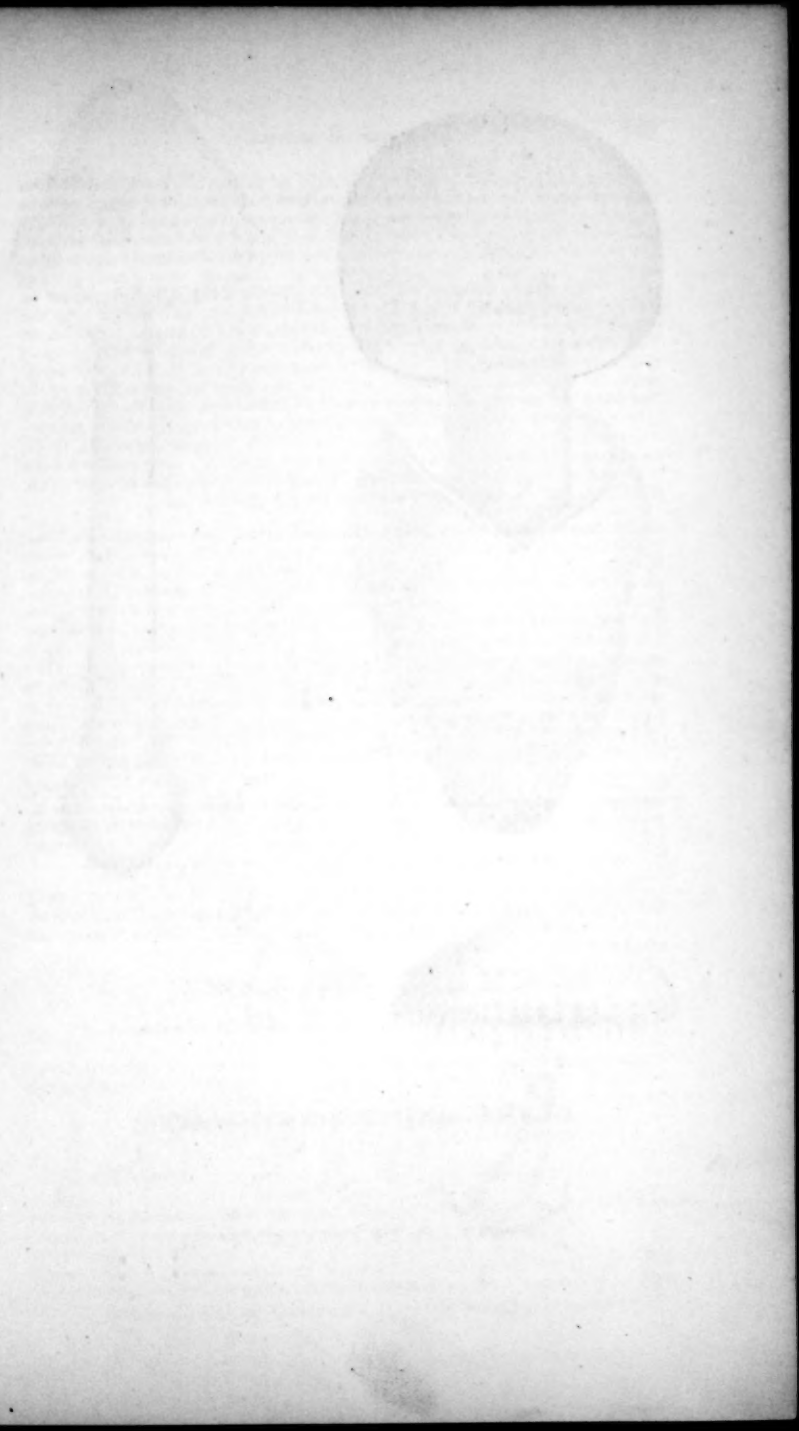
PRODUCTION OF DIABETES BY COLD.—The *Proc. Roy. Soc.*, No. 70, contains a paper by Dr. Bence Jones, on the production of diabetes in rabbits by surrounding them with ice, and thus arresting the processes of oxydation going on in their bodies. The urine of rabbits naturally contains a little sugar, but the quantity was notably augmented by exposing them to a low temperature.

INVISIBLE RADIATION OF ELECTRIC LIGHT.—Professor Tyndall describes the distribution of the heat rays in the electric spectrum, in the *Proc. Roy. Soc.*, No. 71. Melloni, Franz, Müller, and others, found the heat to augment from the violet to the red, while the maximum effect was beyond the red, and at a distance from the red, in one direction, equal to that of the green of the spectrum in the other. The augmentation of temperature beyond the red is sudden and enormous. If the amount of heat in different parts of the spectrum is indicated by a curve following its increase or decrease, a steep peak must be described beyond the red, and this peak is much steeper and more abrupt in the electric than in the solar spectrum. Professor Tyndall supposes that the aqueous vapour in our atmosphere has toned down the solar rays. A solution of iodine in bisulphide of carbon stops all the light rays, and allow the heat rays to pass freely. Professor Tyndall converges the rays of an electric lamp by a concave mirror, stops the light by a screen of the iodine solution, and ignites wood, lights cigars, etc., in the dark focus of the non-luminous rays.

NATURE OF SUN SPOTS.—Messrs. De la Rue, Balfour, Stewart, and Benj. Loewy, have communicated to the Royal Society (see *Proc.*, No. 71) the results of numerous observations on solar spots. The majority confirm the belief that the umbra of a spot is at a lower level, or nearer the crater than the penumbra. The faculæ, or light-streaks, appear to be above the spots at a high elevation in the solar atmosphere. The bottom of the spots is supposed to be of a lower temperature than the photosphere, and this luminous photosphere is considered not to be composed of solid or fluid matter," but rather of the nature of a gas or cloud." Observations of a sun spot, by Professor Phillips, of which details will be found in same publication, detected perspective appearances, which showed that it was, on a whole, not sunk very much below, or raised very much above, the general level of the region. He thinks the black nuclei of spots the sun's body ; the penumbra that body partially seen through the atmosphere. The faculæ, he supposes, transmit rays which have acquired a higher refrangibility than that with which they started.

MR. HUGGINS ON THE ORION NEBULA.—In Mr. Burr's article on Celestial Chemistry, it was stated that Mr. Huggins had obtained a gaseous spectrum from the Great Nebula in Orion. Since then a paper on the subject appeared in the *Proc. Roy. Soc.*, No. 71, containing some fresh particulars. Nebulæ 4760, 4678, in Sir J. Herschel's catalogue, which are "well resolved" by telescopic power, give continuous spectra, indicating their difference from other nebulæ, which give only certain lines of light, indicating that they are gases producing rays of one degree of refrangibility. When the Orion nebula was examined, the light from the brightest part near the trapezium was resolved by one prism into three bright lines, in all respects similar to those of the gaseous nebulæ described in our January number. When the stars of the trapezium were brought upon the slit, continuous spectra were obtained. The whole of the nebula that was bright enough to be examined, gave the same spectrum of three bright lines only. Thus the detection by large telescopes, in this or other nebula, of an assemblage of minute points of light, can no longer be accepted as proof that the object consists of true stars. Mr. Huggins remarks, "it is worthy of consideration that all the nebulæ which present a gaseous spectrum, exhibit the same three bright lines ; in one case only, 18 H. IV., was a fourth line seen." Mr. Huggins' theoretical suggestions are, we think, open to some objection. He says, if we suppose the gaseous substance of nebulæ, the nebulous matter which, by condensation, forms stars, "we should expect a gaseous spectrum, in which the groups of bright lines were as numerous as the dark lines due to absorption, which are found in the spectra of stars." Are we not equally entitled to say we should *not* expect anything of the kind? If the nebulous theory of star formation be accepted, we

should expect the nebulous vapour to consist of matter in a much simpler form than most of the vapours and gases we are acquainted with, and it would only be as condensation progresses that the chemical compounds which we know would be produced. We agree with Mr. Huggins that it would be an improbable supposition to consider the nebulous spectra of three bright lines indicates matter in its *most* elementary forms. The supposed ether of space may be still more elementary, but the nebulous matter very elementary, as compared with other matter in a much more condensed state. Mr. Huggins inclines to the opinion that the gaseous nebulæ "are systems possessing a structure and a purpose in relation to the universe, altogether distinct, and of another order, from the great group of cosmical bodies to which our sun and the fixed stars belong." With great admiration for Mr. Huggins' brilliant discoveries, and great respect for his scientific knowledge, we should, in the present state of information, reject this hypothesis. It seems to us more likely that we must enlarge our chemical theories to take account of the probable nature and properties of matter in so *unterrestrial* a condition as that of the nebulæ, than that we shall be compelled to assume those nebulæ to stand aloof from the general scheme of construction, change, and reconstruction, which apparently enfolds all the bodies in the physical universe.

Professor Phillips on Mars.—In *Proc. Roy. Soc.*, No. 71, Professor Phillips remarks that as the relative solar influence on the Earth and Mars, arising from the different distance of the two bodies, would be as 100 on Mars to 231 on the earth, the surface of the more distant planet might be expected to be in perpetual frost, which is not apparently the case. He considers that its atmosphere may obstruct radiation of dark rays to a greater extent than our own, without differing very materially from ours. He adds: "It seems, however, requisite to suppose a greater communication of heat from the interior of the planet, for otherwise the additional vapour, to which the warming effect is in the main to be ascribed, could not, probably, be supported in the atmosphere." He likewise mentions a curious result arrived at by Mr. Main. "Computing by the known rotation velocity, and the admitted measures and mass of Mars, its ellipticity should be about $\frac{1}{300}$. Mr. Main's observations with the splendid Oxford heliometer give as the most probable result $\frac{1}{37.59}$ for 1862." Professor Phillips found at the late opposition, that the substances round the south pole appeared less extensive than in 1852, and were not really observable with distinctness, except on a few evenings. The axis of Mars being at this opposition nearly at right angles to the line of sight would prevent much snow being seen even if it existed.

The Suez Canal.—M. Lesseps states, that since the 1st of January a daily communication has been established between the Red Sea and the Mediterranean. A boat, containing twenty or thirty people, was tugged by a steamer through the canal in twenty-four hours.